The Effects of Shift Work on the Worker

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ABSTRACT

There are approximately 15.5 million shift workers in the United States who work outside the standard diurnal (daytime) working hours of 7 am to 6 pm. As technology, globalization of industries, and the demands of a 24-hour society continue to escalate, so will the need for more workers to staff the related occupations around the clock. The types of occupations that include a large workforce percentage of shift workers are those that provide a 24/7 continuum of services such as healthcare workers, long-distance truck drivers, airline pilots, as well as a variety of service industry employees who produce goods and services on a continuous basis.

Working non-diurnal hours on a regular basis, more commonly known as shift work, has been linked to many negative health consequences, including cardiovascular disease, gastrointestinal disturbances, sleep disruptions, and excessive fatigue. The reasons for these outcomes and an actual causal relationship between shift work and health effects have been widely debated among researchers. The disruptions to the body's natural biorhythms, or circadian rhythms, caused by shift work seem to be a common thread throughout much of the research in the field.

This paper explores these negative health sequelae currently reported as possibly being caused by the body's inability to adapt to shift work hours. An explanation of the physical manifestations of these effects will be given. The role of the occupational and environmental health nurse as a consultant and educator

will be discussed to minimize the negative effects of shift work and provide realistic solutions in assisting workers to cope with these varying work schedules.

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

CHAPTER 1

INTRODUCTION

The progressive movement toward becoming a 24-hour society, both in the United States and in the global industrial community, can actually be traced back to the discovery of artificial lighting by Thomas Edison in the early 1800's (Monk & Folkard, 1992). It was with the advent of this life altering invention that the business of work and the provision of services no longer had to be confined to daylight hours. Therefore, the beginnings of shift work in the workplace as known in today's industrial environment began. In further review, shift work can also be traced back as early as the 1700's, when Ramazzini, in his early work focusing on occupational health issues, recognized bakers, innkeepers, and soldiers who worked more than normal daylight hours to provide their particular goods and services (Harrington, 2001). In the beginning, there was definite flexibility in shift work and freedom of choice to work at a trade that required non-diurnal hours.

By the time the Industrial Revolution brought the explosion of new technology, use of more expensive machinery, and widespread use of electricity, shift work was quickly becoming not only a choice for workers, but a necessity for the success of many businesses (Glazner, 1991). The advent of the 20th century only solidified round-the-clock work hours as many states began to challenge the constitutionality of the Blue Laws, which had been established in Virginia in the early 1700's to regulate personal and public conduct. A section of the Blue Laws regulated Sunday closings of many businesses for religious reasons

(Kirkland, 2000). From 1961 to 1991, all but 13 states in the United States had abolished Blue Laws governing Sunday work hours (Kirkland, 2000). This fueled the rise of workers working on weekends and shifts that had not previously been an issue. Now, for many of the millions of workers who can only find work during these hours, they must cope with the challenges of shift work, many of which affect workers' health and well-being.

Health effects from shift work, especially those that would be considered negative, are not a new phenomenon. In 1931, a group of pilots requested a study of fatigue based on issues they had from working hours outside of normal daylight hours. In 1946, the first fatigue investigation was conducted. Even though many problems associated with working long work hours were found, no major changes in duty time hours were made, and pilots continued to experience fatigue and complain that they were unsafe to fly (Holley, Sundaram, & Wood, 2003). A stalemate resulted between the National Transportation Safety Board (NTSB) and the Federal Aviation Administration (FAA) over conflicting goals, and no changes were made to working hours. The NTSB's role is to recommend safety improvements, while the FAA is charged with enforcing these recommendations. A conflicting goal for the FAA is to keep airplanes in the air and to meet societal demands for a wide choice of airlines and flight times (Holley et al., 2003). Situations such as this indicate how strong the mandate is in the business world, even more so today in the 21st century, for work to continue 24/7, often without regard for the health effects on workers. Working 24/7 has

indeed reached a point of no return in modern society and it appears that shift work and the resulting effects cannot be avoided.

Even though some of the most reliable data on shift work comes from the early 1900's, research continues on the health and social effects of shift work today (Green-McKenzie & Behrman, 2005). One of the most challenging obstacles to research outcomes is the fact that many workers choose to work non-diurnal hours for a variety of reasons. Those who remain in shift work for a long time and could be a research population are considered a "survivor population". These workers have found ways to adapt to a non-diurnal lifestyle over time (Harrington, 2001). These workers may function without the negative health effects commonly associated with shift work. Therefore, it is difficult to conduct randomized, longitudinal studies that will point directly to a causal relationship between a specific health effect and shift work, especially if the workers in this "survivor population" are participants in the study. This could be one reason that there is research that shows strong evidence of certain health outcomes related to working shift work hours, and other research does not support the same conclusions (Green-McKenzie & Behrman, 2005).

In keeping the best interests of workers in mind, the occupational health professional should assume that negative health effects may arise from possible biological and psychosocial aspects inherent to shift work. Therefore, the occupational health professional must have an understanding of these health issues and become an advocate for workers to find life style adjustments and coping mechanisms that will promote the healthiest adaptation to shift work

(Harma, 1996). The occupational health professional can also be a valuable resource to employers by providing guidance in establishing policies, procedures, and scheduling strategies that will promote the highest level of adaptation to shift work among the workers.

CHAPTER 2

LITERATURE REVIEW

Definitions

Shift Work

The National Institute for Occupational Safety and Health (NIOSH) defines shift work as work that is done outside normal daylight hours, which are generally considered to be from 7 am to 6 pm (National Institute for Occupational Safety and Health [NIOSH], 1997). Shift work can also encompass a broader definition to include work in the evening, the middle of the night, and overtime hours (greater than 40 hours per week) (NIOSH, 1997). Because of the varied needs of industries, shift work can literally be any work schedule that will get the job done in the required time needed to produce the goods and/or services of the specific workplace.

Table 2.1 lists some of the many shift work and sleep definitions. As can be seen by the variety of terms, in addition to various shift work patterns, working non-diurnal hours can give rise to syndromes including those associated with dysynchrony of the human system (Frank & Ovens, 2002). Many of these will be discussed further in this paper. Glazner (1991) states that shift work occurs when work hours go against normal sleep instincts and are opposite human diurnal nature, which is the body's need to be awake during the day rather than asleep.

TABLE 2.1

SELECTED SHIFT WORK AND SLEEP DEFINITIONS

Shift Work	Method of staffing in which different employees work at different times during the day, including times outside the classic 0800-1800 hours. The "shift" is the unit of work time scheduled per day.
Fixed shift schedule	A method of scheduling shift work in which the individual always works the same hours each day.
Rotating shift schedule	A method of scheduling shift work in which the individual periodically changes the shift worked.
Shift rotation rate	A measure of the number of consecutive days an individual works before changing shifts.
Forward rotation	A change in shift to one later in the day, or clockwise, also known as a "delay shift;" the most circadian-friendly method.
Backward rotation	A change in shift to one earlier in the day, or counterclockwise, also known as an "advance shift;" the least circadian-friendly method.
Circadian rhythms	Periodic patterns of physiologic systems (from Latin, "about a day"). In humans, these rhythms have a natural 25-hour cycle, but external cues keep them synchronized to a 24-hour period.
Zeitgebers	Environmental time-cues that modulate circadian rhythms, such as the light/dark cycle (from German, "time-givers"). Without these cues, human rhythms migrate to a 25-hour schedule.
Dysynchrony syndrome	A constellation of effects and symptoms due to a disharmony of circadian rhythms induced by conflicting zeitgebers (such as work phase shift). It manifests as sleep loss, malaise, GI symptoms, irritability, and reduced performance.
Shift work syndrome	A dysynchrony syndrome due to chronic shift work. It is characterized by a constellation of problems including chronic fatigue, GI symptoms, alcohol or drug abuse, higher rates of accidents, mood disturbances, and interpersonal relationship disturbances.
Jet lag	A circadian dysynchrony syndrome resulting from transmeridian travel.
Partial vs. complete sleep loss	Shift work disrupts sleep, leading to partial sleep loss daily, and a cumulative sleep debt. Complete sleep loss involves skipping one entire sleep period, as in staying up all night.
Anchor sleep	Anchor sleep is one method of maintaining sleep hygiene patterns. It involves sleeping a portion of each day's sleep at about the same time, no mater the shift schedule.

Source: Frank & Ovens, 2002.

Rotating Shifts

Rotating shifts can be defined as either forward or backward. Forward rotation is in a clockwise direction and the worker will work day shift, then evening shift, then night shift. In backward rotation, the worker will work day shift, then night shift, then evening shift. After this rotation, the worker will repeat the cycle again (NIOSH, 1997). Many companies use this type of shift work scheduling feeling that it is fairer by allowing all employees to work the popular as well as the unpopular shifts (NIOSH, 1997). Rotating shifts are also characterized by the speed of the rotation. Fast rotation involves changing shifts every 2-3 days, whereas slow rotation can involve changing from one shift to another every 1-2 weeks (NIOSH, 1997). The Agency for Healthcare Research and Quality (AHRQ) studied rotation of shift work, and determined that forward rotation is more likely to be associated with less fatigue and other adverse health effects than backward rotation (2001). In addition to evaluating the direction of the rotating shifts, the AHRQ determined that slower rotations resulted in greater sleep lengths while off-duty, less fatigue on the job, and better performance at work with fewer mistakes (AHRQ, 2001). Much of the research that has resulted in a consensus regarding direction and speed of rotation has centered on the worker's natural circadian rhythms and how they are affected by shift work.

Circadian Rhythms

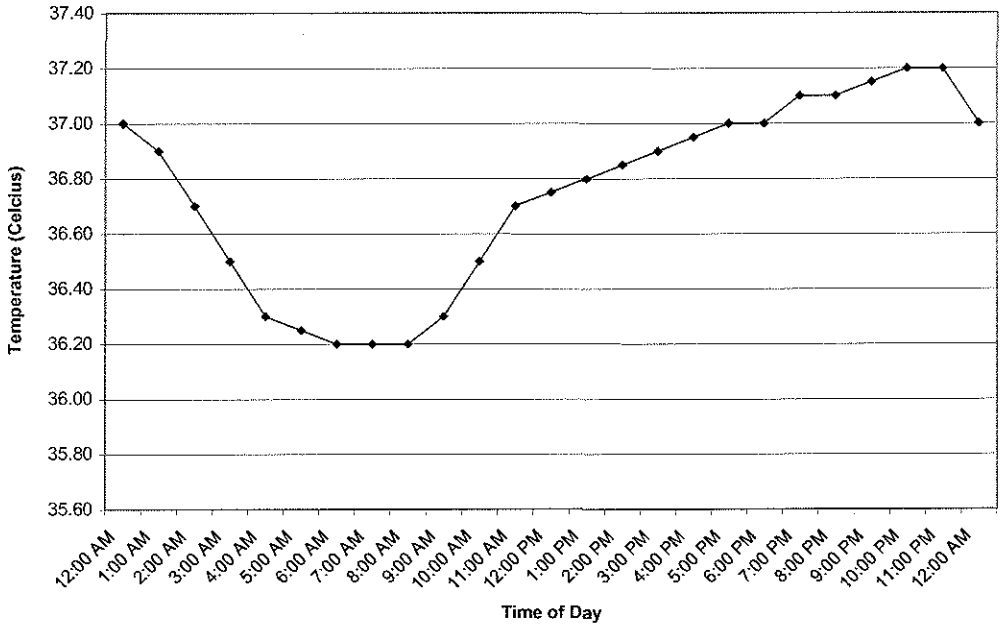
Human beings are by nature diurnal or day creatures, and the human body is more or less controlled by a biological clock that "parallels the regular 24 hour

alteration between day and night as the earth spins on its axis" (Glazner, 1991, p. 417). Circadian rhythms tell the body when to be awake and when to sleep. Body temperature, the sleep-wake cycle, cardiovascular parameters, cognitive performance, endocrine and immunoligic factors, response to certain medications, and psychological variables of mood and anxiety are some of the rhythms that follow a certain cycle (Scott, 2000). Figure 2.1 shows a representative rhythm of body temperature taken throughout the day. Body temperature measurements are often used to illustrate this human phenomenon because of the ease of measurement and the predictability of a pattern throughout a 24 hour period (Monk & Folkard, 1992).

The term circadian rhythm was introduced in the 1960's when scientists isolated humans in an environment where light exposure and clocks were taken away (Green-McKenzie & Behrman, 2005). It comes from the Latin, *circa* (about) and *dies* (a day) (Valle, 1990). Even without light and knowledge of time of day, the subjects instinctively followed a cycle that nearly approximated the natural 24 hour day. This tendency to be awake in the light and to sleep in the dark is largely due to the strong influence of endogenous factors, or internal clock, which is located in the nucleus of the hypothalamus. Exogenous factors are those in the environment that influence rhythms as well (Green-McKenzie & Behrman, 2005). These "time cues" have been called zeitgebers, from the German, meaning "time giver" (Scott, 2000). The most powerful zeitgeber is the light/dark cycle in a 24 hour period. Others are timing of meals, social interactions, and clock time (Green-McKenzie & Behrman, 2005). When the

FIGURE 2.1

CIRCADIAN RHYTHMS: BODY TEMPERATURE



Source: Glazner, 1991, p. 417.

balance between endogenous and exogenous factors is disrupted, as often occurs in shift work, then a state of desynchronization can occur resulting in body rhythms being out of sync with each other (Glazner, 1991).

Many of the health issues associated with shift work can be traced back to this disruption in the natural course of body rhythms. Several variables affect a worker's ability to compensate for the disconnect between endogenous and exogenous factors and working non-diurnal hours, such as working fixed or rotating schedules, age, personality type, and workload (Smith, C. et al., 1999). However, the human circadian rhythms are so strong that it has been postulated that even those workers who have worked shift work for many years never fully experience a true adaptation of their circadian rhythms to their particular non-diurnal work schedules (Folkard & Akerstedt, 2004).

Workers Affected

There are approximately 15.5 million shift workers in the United States (NIOSH, 1997). This comprises approximately 16% of the fulltime workforce recognized in the U. S., and includes evening, night, and rotating shift employees (Geliebter, Gluck, Tanowitz, Aronoff, & Zammit, 2000). The 1997 NIOSH landmark publication, *Plain Language About Shiftwork,* reported additional demographic information regarding shift workers:

- More men work night and rotating shifts than women.
- 2-10% of almost any occupation works evening, night, or rotating shifts.
- Women work more evening shifts and do more part-time work.
- Younger people are more likely to work shift work than older people.
- African-Americans do more shift work than Caucasians.
- More single people work shift work.
- Single mothers work more shift work than married mothers.

- Among dual income couples, one-fourth to one-third has at least one partner working a shift.

There is a very high turnover rate for shift workers, with about 50% of the workers leaving shift work after only one to four months on the job (Sood, 2003). Reasons for this large exodus stem from adverse health effects and the inability to cope with the demands of shift work, both of which will be discussed later in this paper.

In today's 24-hour society, there is the potential for shift work in a wide variety of work environments. For some occupations, shift work is a necessity and not new. A major determinant to whether a workplace has shift work is the nature of the work itself. If the need for services or goods demands it, then the industry will provide 24/7 availability of what is needed (Beers, 2000). Critical services, such as police, fire and emergency medical services (EMS) , military defense, healthcare, transportation, and public utilities, such as telephone, electrical power, and water must maintain around the clock workers to provide continuation of services (Sood, 2003). Industrial worksites that operate 24 hours a day often have machinery for the production process that is cost prohibitive to shut down on a daily basis. The industries reporting high percentages of shift workers and the most 24/7 operations are those manufacturing paper products (33.3%), automobiles (31.3%), and mining (24.8%) (Beers, 2000). With increasing technology and more global operations, many industries must do business with world wide locations at night, and on weekends and holidays. There are fewer shift workers in the public sector than the private sector, and this varies only slightly across federal, state, and local governments (Beers, 2000).

Healthcare Workers

Healthcare workers comprise a large percentage of shift workers. Among those full time healthcare workers, 30.1% are shift workers with 10.8% working in the evening, 9.4% working at night, and 3.3% working rotating shifts. A small percentage of the workers have other shifts arranged outside of daytime work hours (Hughes & Stone, 2004). The healthcare profession is the exception to the demographic given by NIOSH stating that more men work shift work. The majority of shift workers in healthcare are women (Glazner, 1991). The healthcare field is broad, including nurses, physicians, residents, interns, EMS personnel, and other support staff who provide services other than patient care. In addition to the stress of life and death situations relating to patient care, the healthcare worker needs alertness, sound judgment, and often quick reaction times, especially in emergency situations (AHRQ, 2001).

The added physical strain of trying to adapt to shift work can be extremely detrimental to this group of professionals. Shift work has been cited as one of the main causes of physicians leaving the practice of emergency medicine (Frank & Ovens, 2002). Emergency physicians tend to have high rates of divorce, burnout, and attrition from the practice of emergency medicine (Frank & Ovens, 2002). In addition to established physicians, medical school graduates, as interns, will often work additional long hours to pay off school loans, adding to the burden of adapting to already assigned shifts (AHRQ, 2001).

A survey published in the October 2004 issue of the *Journal of Emergency Medical Services* found that paramedics are at the top of the list of most stressed

workers in the United Kingdom. The survey cites extended work hours as a leading cause of this stress (Monosky, 2004). This demanding career is made more difficult by the necessity of shift work, and has resulted in higher rates of drug and alcohol abuse, depression, cardiac risk, and other stress-related health risks (Monosky, 2004).

The fact that shift work so significantly impacts the healthcare segment of the workforce is important to remember when assessing the quality of patient care. The well-being of a patient may be jeopardized if a fatigued, sleep-deprived healthcare worker performs surgery, administers medications, mismanages a medical crisis, or has to deal with a challenging cognitive issue (Weinger & Ancoli-Israel, 2002).

Long Distance Truck Drivers

Trucks that deliver goods around the clock are a necessity for a rapidly growing industrial society. Long distance truck drivers deal with the negative effects of shift work and the far reaching consequences in road safety. From 1994-1998, the Federal Highway Administration (FHWA) conducted a comprehensive review of commercial driver alertness while driving, and the findings substantiate the impact of sleeplessness and shift work on this population of workers (U. S. Department of Transportation, 2001). Among the findings were the following:

- Drivers were more than 8 times more likely to experience drowsiness between midnight and 6 a.m.
- Drivers usually only slept for about 5 hours at a time.
- Drivers were unable to accurately assess their own levels of alertness related to their performance.

Oftentimes, trucks are banned from congested streets during daytime hours forcing drivers to work evening, night, and weekend hours to deliver assigned loads (Circadian Information, 2000b). The monotony of long hours on the road, coupled with sleep deprivation often has disastrous consequences for long distance drivers, evidenced by crashes where there were no road skid marks indicating that the driver was asleep and simply drifted into oncoming traffic, or a road obstacle.

Airline Pilots

As mentioned in the introduction, the airline industry pioneered much of the research in the early 20th century in the area of fatigue and its effect on the worker. Longer work hours for pilots and other airline personnel increased rapidly with the increase in transcontinental travel. Long haul flight crews routinely deal with additional issues involving long work hours. Specifically, rapid sequences of transmeridian flights, longer flight hours, irregular duty and rest schedules due to nighttime and daytime flying, and layovers in different time zones combine to make these workers more prone to sleep loss, disruptions in circadian rhythms, and impaired performance (Holley et al., 2003). Unfortunately, there has been little change in improving scheduling for aviation workers, despite some real advances in knowledge of fatigue factors that are specific for this working population (Holley et al., 2003).

Rationale for Shift Work

Shift work has become a product of a society that operates 24 hours a day on a local, national, and global level. The growth of the number of workers

working outside of daytime hours is a product of both employer as well as employee needs and choices.

Employers

Employers feel the pressure of keeping up with economic demand for goods and services, and often resort to shift work out of this economic necessity without serious regard to the health and well-being of employees and the negative health effects that shift work may have on that population (Monk & Folkard, 1992). The employer realizes the cost efficiency of operating machines around the clock mainly because of start up and shut down expenses (NIOSH, 1997). In addition, machines running constantly can yield more of a profit for the company (Monk & Folkard, 1992). Another pressure felt by employers is the high cost of recruiting and hiring personnel. This has given rise to employers either offering or requiring overtime in order to save on recruiting and retraining costs (Hetrick, 2000). In the period from March 1991 to 1997, the average weekly hours of overtime in the manufacturing arena increased by 1.6 hours, which was the highest increase since statistics were gathered in 1956 (Hetrick, 2000).

Service industries, such as healthcare, police, fire, EMS, military defense, transportation, and public utilities have given rise, much like a "domino effect," to the creation of shift work in other businesses. Grocery stores, gas stations, and restaurants may be open for business at any time, and this happened mainly to serve others working non-diurnal hours. "Because there are so many shift workers, society now needs more shift workers" (NIOSH, 1997, p. 2).

Employees

For many employees, shift work is a choice for employment and is not thought of as a negative issue. Employees have many reasons for choosing shift work, including child care issues, greater flexibility, more free daytime hours for personal or family reasons, shift incentives, and time allowed to pursue daytime educational opportunities (Frank & Ovens, 2002). Table 2.2 shows a breakdown of the 15 million shift workers in May 1997, and their reasons for choosing a particular shift. Of special note is that greater than half of all the full-time employees who worked a non-diurnal shift did so because of the nature of the job. These are employees who purposely chose those occupations where shift work is likely, for example, the healthcare profession, or chose the only employment available to them (Beers, 2000).

Laws and Regulations Specific to Shift Workers

Few laws and regulations exist today that govern employers regarding shift work. Even though employees are guaranteed a safe work place under the General Duty Clause of the Occupational Safety and Health Act, employers have generally interpreted the law to be related to physical acts of safety in the work place rather than health and safety issues related to the potential negative effects of shift work hours (Sood, 2003). Historically, more attention has been given to the protection of women and children who work long hours. In the early 1800's, child labor laws prohibited children under the age of 18 from working during the night time (Glazner, 1991). Women were added to this law by the end of the 1800's, with only a few exceptions, such as midwifery (Glazner, 1991). Then

TABLE 2.2

SHIFT USUALLY WORKED ON PRINCIPAL JOB BY USUAL FULL-TIME WAGE AND SALARY WORKERS, BY REASON FOR WORKING SHIFT, MAY 1997

(Numbers in thousands)

		Shift worked					
Reasons for working shift	Total	Evening	Night	Rotating	Split	Employer arranged irregular shift	Other shift
Total shift workers	**15,183**	**4,192**	**3,156**	**2,649**	**350**	**3,523**	**1,313**
Better child care arrangements	633	279	257	31	3	35	28
Better pay	920	350	330	81	14	105	41
Better arrangements for care of family members	423	114	214	17	5	38	34
Allows time for school	435	201	62	56	11	86	19
Easier commute, less traffic	109	51	27	4	2	12	13
Could not get any other job	866	383	237	75	12	138	20
Mandated by employer to meet transportation/pollution program requirements	1,967	397	326	561	55	524	103
Nature of the job	7,767	1,710	1,084	1,610	204	2,354	805
Other reasons	1,912	661	581	195	41	224	211
Not reporting reasons	151	46	37	19	3	7	38

Note: Data relate to the sole or principal job of full-time wage and salary workers who were at work during the survey reference week and exclude all self-employed persons, regardless of whether or not their businesses were incorporated. Data reflect revised population controls used in the Current Population Survey effective with the January 1997 estimates.

Source: Beers, 2000, p. 39.

there seems to be a chasm of time when long work hours and their consequences were not addressed for any demographic group.

The Fair Labor Standards Act of 1938

Although this legislation was not actually intended to address shift hours directly, the purpose was to legislate fairness in compensation for the hours that employees did work. The Fair Labor Standards Act of 1938, Maximum Hours, Section 7 (a) (1), specified that if a worker worked longer than forty hours per week, then the employee would receive payment at one and one-half times his/her regular rate at which he/she was employed. Representatives of the National Labor Relations Board negotiated wording in the act that specified that during a period of 52 consecutive weeks:

> Employees would not be employed more than two thousand two hundred and forty hours (2,240) and shall be guaranteed not less than one thousand eight hundred and forty hours (1,840) (or not less than forty six weeks at the normal number of hours worked per week, but not less than thirty hours per week) and not more than two thousand and eighty hours of employment (2080) for which he shall receive compensation for all hours guaranteed or worked at rates not less than those applicable under the agreement to the work performed and for all hours in excess of the guaranty which are also in excess of the maximum workweek applicable to such employee (The Fair Labor Standards Act of 1938, Maximum Hours, Section 7 (b) (2)).

This Act was also among the first legislations to recognize benefit time that could be earned by time worked. By the very nature of this legislation, the issue of long work hours had reached a point of such significance that fairness in compensation for working overtime needed to be addressed legally.

Laws Governing the Medical Profession

After the death of a patient in New York State in the 1980's was linked to fatigue and sleep deprivation of the treating resident, an outcry of public opinion led to new regulations stating that residents could only work a maximum of 80 hours per week, 24 consecutive hours, and a minimum of 8 hours off duty between shifts (AHRQ, 2001). Hospitals were mandated to comply and change their work hour policies, but in 1998, it was found that many were ignoring the regulations. Thirty seven percent of all residents who were interviewed volunteered that they worked more than 85 hours per week, and 67% of all surgical residents were working more than 24 consecutive hours (AHRQ, 2001). By the year 2000, citations were still being given to hospitals that were inspected by the Accreditation Council for Graduate Medical Education for violations (AHRQ, 2001).

There is, however, a recognition that the long hours worked by physicians, residents, and interns needed to be taken seriously as patient care may be affected. Green-McKenzie and Behrman (2005) reported that the American College of Emergency Medicine Physicians Practice Management Committee recently made changes in its Emergency Physician policy on shift work. Those changes included rotating shifts in a clockwise direction, working only one night shift or one shift at long stretches, shortening hours per shift, offering incentives for night shift workers, and paying more attention to staffing and scheduling issues while giving consideration to patient volume and acuity. Although this is not a law in the true sense, it did make an attempt to regulate a large portion of healthcare

workers who may experience fatigue, sleep deprivation, and consequently deficits in safety and performance due to shift work.

Laws Governing Motor Vehicles

Driving a motor vehicle while fatigued or sleep deprived has very obvious devastating consequences. The question of culpability in sleep-deprived related accidents is one that has recently come to the forefront of many legal battlegrounds. Even on a global scale, it is the employer who is now facing legal ramifications when an employee is involved in a motor vehicle crash (MVC) either commuting to or from work (Rajaratnam & Arendt, 2001). This trend will place the burden on employers to find ways to ensure that the shift work necessitated by the service provided or the production process does not cause workers to become so fatigued and sleep-deprived that they cannot safely commute to and from the workplace.

The employee will still face the consequences of a MVC that is caused by ignoring precursory feelings of sleepiness. The state of New Jersey recently made changes to its vehicular homicide statute, and added "driving after having been without sleep for a period of excess of 24 consecutive hours" to its definition of reckless driving (Barger et al., 2005). Under this statute, drivers would be subject to a charge of criminal homicide if it could be proven that they had been awake in excess of 24 hours (Barger et al., 2005). This law, and similar legislation in New York, Massachusetts, and Michigan, places employees and employers at increased liability as the employer could also be cited for having the employee work more than 24 hours. The hours of continuous work could be documented by work logs

and schedules (Green-McKenzie & Behrman, 2005). It is possible that laws like this and other similar laws would address driving while sleep deprived in the same way that driving while alcohol impaired is currently regarded (Rajaratnam & Arendt, 2001).

The Federal Motor Carrier Safety Administration (FMCSA) is the regulatory agency that is charged with enforcing the rules and regulations set forth for commercial, long-distance truck drivers. The initial hours of service (hours of time driving) were established in 1939, and for nearly 60 years remained without a significant revision (Federal Motor Carrier Safety Administration [FMCSA], n.d.). Through a federal directive, the FMCSA was commissioned to study research including years of driver fatigue, sleep disorder data, and changes brought to the transportation industry by better road design and overall improvements in safety for drivers. As a result, in April, 2003, FMCSA presented the first revision to the hours of service regulations and set, as a mandate for compliance, January 4, 2004 (FMCSA, n.d.). With some exemptions to the rule, such as waivers for agricultural transport of goods during peak seasons, the basic components of the new rule are as follows:

- Drivers may drive up to 11 hours instead of 10 hours, but are limited to 14 hours in a duty period.
- The 14-hour duty period may not be extended with off-duty time for meal and fuel stops, etc. Only the use of a sleeper berth can extend the 14-hour on-duty period.
- Each duty period must begin with at least ten hours off-duty, rather than eight.
- The 60 hours on-duty in 7 consecutive days, or 70 hours on-duty in 8 consecutive days, remains the same, but drivers can "restart" the 7/8-day period by taking at least 34 consecutive hours off-duty.

(FMCSA, n.d.)

Laws Governing Airline Workers

There have been significant technological improvements in engineering and control management of aircraft, and while this is important to air traffic safety, it points more to human error than ever before for the number of airline crashes. Human error is now blamed for 66% of all commercial airline accidents, 79% of commuter aircraft accidents, and 88% of all private aviation accidents (Circadian Information, 2000a). The National Aeronautics and Space Administration (NASA) created a confidential reporting system in 1975 titled Aviation Safety Reporting System. The purpose of this system was to gather data on accidents and near-misses in the aviation industry in the hopes of developing information that would be helpful in preventing catastrophes caused by airline crashes. Of the more than 10,000 reports received each year, the overwhelming majority cite fatigue as a major factor (Holley et al., 2003). Information from this site is also used to influence legislators and regulators "so that practices that ensure aircrew alertness are allowed and promoted, and counterproductive regulations are banished from the books." (Circadian Information, 2000a, p. 6.7).

Even with a wealth of data on airline worker fatigue, pilot error, and the negative impact of long work hours, the Federal Aviation Regulations, which govern commercial aviation scheduling practices, continues to place work demands on airline personnel which can lead to compromised safety. Since the 1930's, there has been very minimal changes in regulations that govern how airline crews are scheduled (Holley et al., 2003). As the consumer demand for additional choices of flights and flight times increases, the struggling airline

industry may be forced to choose profit over safety concerns in order to stay competitive. As far as governing regulations are concerned, it may take major airline disasters citing fatigue as the root cause to create the political pressure that is needed to accomplish change that would translate into safer airline travel (Holley et al., 2003).

CHAPTER 3

THE HEALTH EFFECTS OF SHIFT WORK

As researchers attempt to find a causal relationship between shift work and negative health effects, they are hampered by the fact that truly randomized, longitudinal studies of shift workers are often not possible. Many workers who begin to develop problems will leave shift work and move to day jobs when they find them, leading to a selection bias known as the "healthy worker effect" (Demerouti, Geurts, Bakker, & Euwema, 2004). Another obstacle to research outcomes is that the negative health symptom(s) shift workers may experience are just a natural or expected side effect of their working situation. By assuming that these symptoms are to be expected, shift workers underestimate the potential seriousness of the problem (Demerouti et al., 2004). It is estimated that nearly 20% of shift workers will develop negative health symptoms when assigned to shift work, especially night shift work (Scott, 2000).

Nearly every system in the body is either directly or indirectly affected negatively by shift work (Muecke, 2005). There are varying degrees at which these effects are debilitating to the human body, and some workers will actually adapt and function well through their careers (Scott, 2000). However, for some workers, these negative health effects will put such a strain on one or more systems in the body that they cannot adapt. This outcome has been named shift work maladaptation syndrome, described as an aggregate of signs and symptoms that are present in workers who simply cannot tolerate shift work and function in a well state (Scott, 2000). This intolerance is characterized by the following:

- Sleep alterations: poor sleep quality, difficulty falling asleep or staying asleep,
- Persistent fatigue: not going away after rest periods,
- Changes in behavior: i.e. irritability,
- GI problems, and
- Regular use of sleeping pills

(Scott, 2000).

There are also many independent variables that affect a worker's ability to adapt to irregular work hours. These include, but are not limited to: age, marital status, level of education, sleep patterns, income, lifestyle habits, years in shift work, general health, environmental, and social support (Fischer, Morata, & Latorre, 2001). The ability to adapt appears to be most affected by sleeping habits (rigid or flexible), the ability or inability to overcome drowsiness, and whether a worker is a "morning person" or an "evening person" (Glazner, 1991).

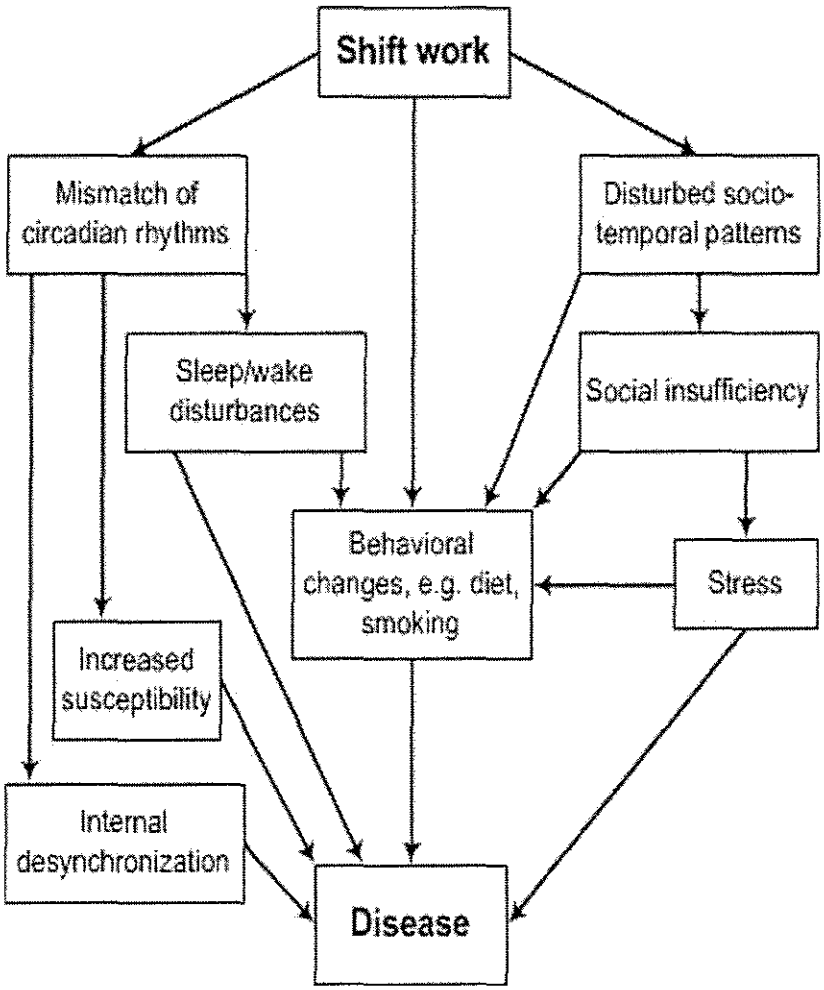
To document a causal relationship between shift work and the onset of negative health problems, researchers have presented conceptual models of how workers adapt to shift work, from a very simple explanation to a more complex interplay among factors. In 1981, Rutenfranz focused on the stress to the human body caused by alterations of sleep and waking patterns (Smith et al., 1999). Monk, a prolific researcher in the field of shift work, presented a theory relating the balance between the biological clock, sleep, and social/domestic issues as key predictors of successful adaptation to shift work (Smith et al., 1999). In 1990, Olsson expanded on Monk's theory by adding job perception and coping skills to the mix. He also viewed shift work as only one component influencing health (Smith et al., 1999).

Regardless of the exact cause(s) of negative health effects in shift workers, there is enough research to point to this as an issue not to be ignored in the workplace. Adverse health issues can surface at any time during the career of the shift worker; however a 1979 research study by Kundi contends that shift work has its most significant effect on health during the first 5 years of employment (Baker, Roach, Ferguson, & Dawson, 2004). Even those who left shift work due to health problems will continue to have poorer health than those presently working shift work hours (Demerouti et al., 2004). Figure 3.1 shows a conceptual model of disease mechanisms in shift workers, illustrating the interplay of many factors contributing to disease from shift work. At any point in this progression, the worker might notice physical and/or emotional changes that would cause them to seek medical attention. Unfortunately, shift workers, as a group, tend to seek medical care less than their day worker colleagues (Glazner, 1991).

Working shift work hours does not necessarily always mean ill effects for workers. Some benefits of shift work given are greater flexibility in hours to pursue other interests, access to services open only during week days, and successful cohabitation with other shift workers who support the lifestyle that comes with working other than day time hours (Glazner, 1991). More often than not, though, the result of shift work is some degree of negative health effect and/or disease state. Health problems have a broader impact than just those that affect the individual worker. Table 3.1 shows the potential negative effects of shiftwork, not only at the individual level but also at the organizational and professional level. Several of the more common negative health effects will be

FIGURE 3.1

A CONCEPTUAL MODEL OF DISEASE MECHANISMS IN SHIFT WORKERS



Source: Knutsson & Boggild, 2000, p. 368.

TABLE 3.1

POTENTIAL NEGATIVE EFFECTS OF SHIFT WORK

PROBLEM	INDIVIDUAL LEVEL	ORGANIZATIONAL (HOSPITAL/EMERGENCY DEPARTMENT/GROUP) LEVEL	PROFESSIONAL LEVEL
Medical	Fatigue and sleep loss Decreased alertness Coronary artery disease Motor vehicle collision Other trauma Peptic ulcer disease Other GI symptoms Decreased immunity Infertility Exacerbated diabetes Exacerbated epilepsy Increased smoking Poor diet	Absenteeism Accidents Errors Decreased productivity	Recruitment and retention problems Burnout and attrition specialty
Psychological	Irritability Depression and negative moods Substance abuse Decreased motivation and burnout Diminished memory Communication problems	Poor group dynamics Relationship difficulties Decreased patient satisfaction	Burnout and attrition specialty Decreased public perception
Social	Isolation Family challenges Decreased sex life Divorce	Isolation Less teamwork	Decreased public perception

Source: Frank & Ovens, 2002.

discussed in greater detail in the following sections.

Cardiovascular Problems

It was not until 1986 that an important research study by Anders Knuttson et al. linked shift work with a higher incidence of cardiovascular disease as compared to a control group of daytime only workers (Monk & Folkard, 1992). Knuttson continued his work through the 1990's and in another study found a significant association between shift work and myocardial infarctions, or heart attacks. In this study, he controlled for confounding factors such as job strain, smoking, and job education level (Knuttson, Hallquist, Reuterwall, Theorell, & Akerstedt, 1999). From early skepticism in the 1960's and 1970's of any link at all between shift work and cardiovascular disease (CVD), research studies have continued to substantiate Knuttson's original theories. Akerstedt and Knuttson (2000) point to two studies supporting this link: 1) 504 paper mill workers followed for 15 years, in which a "dose-response" can be seen between the years spent in shift work and the incidence of coronary artery disease (CAD) (i.e. the longer the years in shift work, the greater the incidence of CAD), and 2) a study of 79,000 female nurses showed the same result. Some research has focused on known causes or precursors of CAD, such as hypertension, and has explored the possible link between shift work and these known risk factors. Such a study was conducted on male Japanese workers by Sakata et al., and the result was a significant relationship (OR 1.10) between the onset of hypertension and working shift work hours (Sakata et al., 2003).

Concern about the effects of shift work on the incidence of CVD is important. Approximately 7% of the currently reported 15.5 million shift workers in the United States are reported to have one or more symptoms of CVD, which means that more than 1 million of these workers have the potential for the sequelae of CVD, namely heart attacks and strokes (Ha & Park, 2005). The main CVD risk factors—obesity, high triglyceride levels, and low HDL cholesterol levels—tend to be seen more often in shift workers than in day workers (Ha & Park, 2005). Other blood components shown to increase during night work are potassium, uric acid, glucose, cholesterol, and total lipids, showing that working these hours tends to have a "catabolic effect", contributing to cardiovascular damage (Knutsson & Boggild, 2000). Cigarette smoking has been frequently linked to increased risk for CVD, and Monosky (2004) points out that six years of shift work is equivalent in negative cardiac health effects to smoking a pack of cigarettes a day for that period of time.

The risk of CVD is also closely tied to the natural circadian rhythms in the human body. Blood pressure and heart rate naturally tend to decrease during the night hours, and workers who are active during night hours put their bodies in an opposite state of function. This can lead to a higher incidence of ischaemic heart disease in night shift workers (Muecke, 2005). Such activity during a time when the body expects rest could also lead to changes in electrical cardiac function, which in turn can lead to life threatening arrhythmias and prolonged repolarization of the heart after beating (Knutsson & Boggild, 2000). Knuttson et al. (1999) took this theory even further by claiming that a disturbance in the

natural circadian rhythms in the body could be a very strong biological marker for increased susceptibility to CVD as well as an actual cause. Even the occurrence of cardiovascular related health effects follows somewhat of a circadian rhythm, with the greatest incidence of morbidity and mortality occurring during the morning hours (6 am to 12 pm). The risk factors of age, previous CVD history, cigarette smoking, or caffeine consumption did not seem to affect this phenomenon (Valle, 1990).

Psychosocial factors associated with shift work can also have a contributing role in the onset of CVD. Shift workers are known to have increased stress, poor diets, and poor exercise patterns and these can have an impact on cardiovascular pathology (Muecke, 2005). Another contributing factor is job strain, which relates to the psychological demands on workers and the amount of decision making or control that they might have over a job situation (Knuttson et al., 1999). Demographically, there is a high percentage of shift workers who are unskilled workers, lower civil servants, and those of low socioeconomic class. CVD has been shown to be related to socioeconomic status (Knuttson et al., 1999).

The exact link between CVD and shift work remains open for interpretation (Knutsson et al., 1999). However, researchers are moving toward a clearer explanation and causal determination through studies of 1) disrupted circadian rhythms, 2) psychosocial factors, and 3) unhealthy patterns of behavior such as increased smoking and poor nutrition among shift workers (Steenland & Fine, 1996).

Sleep Disorders/Disruptions

Shift workers must constantly deal with the detrimental effects of sleep disorders and disruptions. Disruptions to the normal process of sleep can have serious health effects not only for workers, but can also pose problems for employers, fellow workers, and the community at large. Sleep deprivation can lead to symptoms of "shift-lag" which is characterized by:

- Sleepiness, sleeping at work,
- Sleep disruption during daytime sleep,
- Decreased vigilance and attention,
- Impaired performance,
- Irritability,
- GI dysfunction, and
- Depression and apathy

(Scott, 2000).

There are important stages of sleep that constitute a progression toward wakefulness and alertness. The initial stage of sleep lasts about 10-15 minutes and it is the "falling asleep" segment. The largest portion of the sleep cycle (~50%) is a 2nd stage, and the 3rd and final stage of deep sleep is the one that is most important for repair of bodily damage (Green-McKenzie & Behrman, 2005). The minimum number of hours of sleep required for successful functioning during the daytime is approximately 6.5 hours, and the normal amount of sleep required for an adult is between 6-9 hours (Akerstedt & Knutsson, 2000). Night shift workers usually get the least amount of sleep while evening workers get the most sleep (NIOSH, 1997). Employees who regularly work at night may have chronic sleep deprivation, averaging only 4-6 hours, while day and afternoon workers average 7-9 hours (Scott, 2000). It is very difficult to sleep during the day, due to environmental encroachments, such as noise and light, and even the

quality of day sleep is less because it is a lighter sleep (NIOSH, 1997). In addition to environmental disruptions, night workers' sleep is also disrupted by social and job requirements and domestic responsibilities (Scott, 2000).

Circadian Rhythms and Sleep Disruption

The circadian rhythm of the body naturally guides sleeping and waking hours. Night shift workers who must sleep during the day are going against their own natural body rhythms and signals, and are at risk of negative physical effects (NIOSH, 1997). Endogenous factors, or internal clocks, and exogenous factors, or external time cues, have been previously discussed. It is the balance between these two influential factors that synchronizes the body and circadian sleep rhythms to a 24 hour earth rotation (Green-McKenzie & Behrman, 2005). The day-work/night-sleep pattern is the better one for humans, and has been shown to result in better job performance and greater safety on the job (NIOSH, 1997). Working at night is the body's attempt to fight the natural circadian rhythms regulating the body.

The production and secretion of melatonin, the principal hormone of the pineal gland, has its own circadian rhythm and is closely linked to the quality of sleep. In humans, sleep begins during the part of the cycle that is the rising phase of melatonin secretion, which is usually in the evening (Rajaratnam & Arendt, 2001). If workers attempt to sleep at abnormal times during the circadian cycle, such as when the level of melatonin is dropping, then they have shorter sleep episodes with easier wakening (Rajaratnam & Arendt, 2001). This happens often, especially in workers on the night shifts. The consequences of this chemical

imbalance, that is, staying awake when melatonin is freely circulating in the blood stream, can actually be a work hazard, and closely approximates a state of alcohol impairment in a day worker (Monk & Folkard, 1992).

Melatonin levels in the blood are an excellent measure of a worker's natural circadian rhythm as they tend to be more resistant to internal and external influences, as opposed to body temperatures which can be widely affected by sleep, posture, exercise, meals and light (Griefahn, Kunemund, Golka, Their, & Degen, 2002). By examining the melatonin production in a human being (salivary levels approximate plasma levels for research purposes), it can be determined that an employee is either a "morning person" or a "night owl". This can provide invaluable information to an employer as to whether a worker will be able to tolerate and adapt to shift work (Griefahn et al., 2002). There are many hazardous and safety sensitive jobs where optimal alertness and performance are crucial. Therefore, it would be prudent for employers to ensure that employees who are assigned to evening and night work in these sensitive jobs are actually those who exhibit a more effective adaptation to working non-diurnal hours. Questionnaires have been developed to assess morningness and are adequate tools for most jobs when assessing level of adaptation. However, some workplaces have employees working with very expensive and dangerous machinery, and for these employers, having a biological basis for assigning shift workers, such as laboratory levels of melatonin, could be more cost efficient in the long term (Griefahn et al., 2002).

Fatigue

The onset of fatigue is due to a combination of the amount of sleep obtained and the time of day slept (Muecke, 2005). Fatigue is the most common complaint among those who work shift work hours and is very often the main reason that workers are unable to tolerate shift work (Harrington, 2001). It has been blamed for some of the world's worst and most publicized disasters. Events such as the Chernobyl nuclear reactor catastrophe, Three Mile Island episode, the Exxon Valdez oil spill, and the space shuttle Challenger disaster have all been linked to errors by workers who had been awake and working for long hours (Harrington, 2001). Fatigue has also been linked to other problems involving shift workers, such as decreased performance, workplace injuries, and driving accidents and near misses. These three areas will be examined in further detail as critical results of worker fatigue and a serious health consequence of shift work.

Performance

As early as the 1920's, employers were experimenting with reduction of work hours and addition of break times in order to increase and improve the performance level of workers. Harrington (2001) cites an efficiency study done by H. M. Vernon in 1920, where work hours were reduced by 7-20 hours per week and 10 minute breaks were added to the work day in a munitions plant, thereby increasing production by 5-12% of much needed arms for World War I. These findings were substantiated by six other major studies conducted between 1949 and 1978 (Monk & Folkard, 1992). More recently, Folkard and Tucker (2003) discovered a cyclical trend in human performance when safety and

efficiency were measured across all three shifts in a 24-hour period. The results showed a dip in efficiency during the night shift from 10 pm-6 am with the largest dip coming at 3 am. There was a secondary dip after noon, but this could have been confounded by the ingestion of food. The researchers also postulated that the most efficient parts of the day for workers are between the hours of 7 am–5 pm, the basic daytime work schedule. They point to early theories for an explanation of these differences between performance efficiencies in that either "mental fatigue" builds up during waking hours, or the circadian rhythm of sleepiness is an independent factor of whether workers actually slept or not, thereby leading to an inability to perform optimally, because workers are fighting sleep (Folkard & Tucker, 2003).

Job performance is related to safety and the incidence of workplace injuries, but Monk and Folkard (1992) propose that there can be deficits in performance without safety being impaired or workplace injuries/accidents occurring (workplace injuries related to fatigue will be discussed later in this paper). On-shift performance can be affected by a complex combination of factors, some of which affect performance directly, such as the demands of the job (i.e., levels of vigilance, physical and cognitive requirements), and others that indirectly affect work performance, such as individual worker differences (i.e., age, personality, sleep needs) associated with varying degrees of adjustment and adaptation (Monk & Folkard, 1992). The importance of circadian rhythms cannot be diminished when evaluating human performance levels. Variations in alertness and performance on specified tasks show that this flow is at its lowest

ebb at night time, and this pattern does not adjust well, even over successive shifts on night duty (Folkard & Tucker, 2003). Statistics gathered from the public utilities occupations suggest a clear circadian pattern in the occurrence of mistakes, with the highest incidence of mistakes occurring during the late afternoon and early morning hours, specifically at the end of a long shift (Glazner, 1991). Figure 3.2 illustrates how all the various factors affecting shift work can lead to variations in on-the job safety and efficiency.

Workplace Injuries

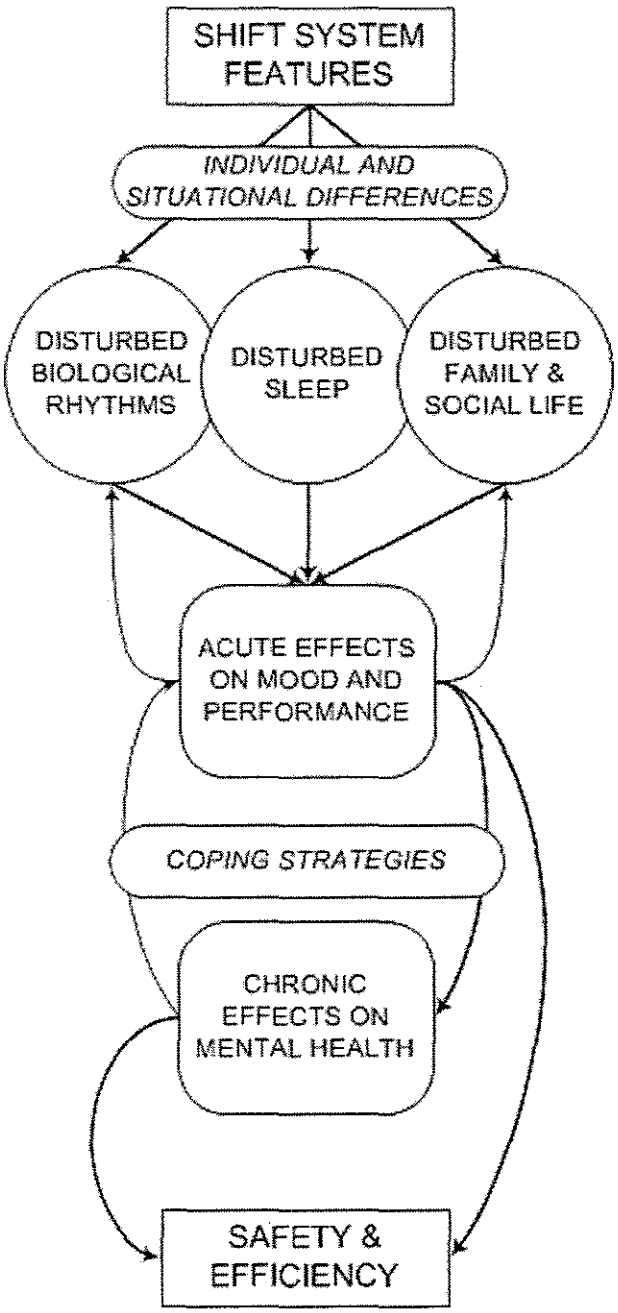
More than 5 million injuries per year are labeled 'work-related' resulting in direct and indirect costs in excess of $50 billion per year (Frank, 2000). Even though substantial research does not exist that clearly links shift work to workplace injuries, the prevailing hypothesis is that fatigue definitely plays a role in these injuries (Frank, 2000). Workplace accidents and injuries tend to be a result of a combination of increased fatigue and lower performance, both of which have been strongly linked to shift work, especially night shift work (Harrington, 2001).

One research study confirmed shift work to be an increased risk factor in workplace accidents by comparing the accuracy of performance between shift workers and alcohol impaired workers. Performance tests on workers who had worked a straight 24 hours demonstrated the accuracy levels of someone whose blood alcohol level was 0.10% (Muecke, 2005).

FIGURE 3.2

A COMPREHENSIVE MODEL OF SHIFT WORKER PERFORMANCE

BY FOLKARD (1993)



Source: Monk, Folkard, & Wedderburn, 1996, p. 22.

Those workers who work rotating shifts and night shifts are more susceptible to workplace accidents than their day worker counterparts (Muecke, 2005). It is very important, however, to take into consideration possible confounding factors that may prevent absolute statements of shift differences when comparing the incidence of workplace injuries across all shifts, especially if the statistics will be used to make organizational changes. For example, many times day workers have the heaviest workloads, which might lead to a greater risk of accidents, while routine maintenance and repair work, not commonly associated with a high rate of injuries, is saved for the night shift (Folkard & Akerstedt, 2004). Another confounding factor includes the number of workers per shift, which is usually fewer on night shifts and the fact that, historically, fewer injuries are reported by night shift workers compared to day workers (Folkard & Akerstedt, 2004). Therefore, it would be better to report accidents as a rate or percentage, or the number of accidents/injuries per number of workers on that shift.

Glazner (1991) reports on a study that supports the theory of increased injuries at night, particularly between the hours of 10 pm and 2 am, as well as her own findings of increased injuries in firefighters on night shift duty. Folkard et al., (2005) also found that the length of the shift has a bearing on the relative risk of incidents, with 10-hour shifts showing a 13% increased risk and 12-hour shifts showing a 27% increased risk. Finally, Folkard and Akerstedt (2004) found that the risk of workplace incidents increased with successive night shifts. Over successive night shifts, the risk on average was about 6% higher on the second

night, 17% higher on the third night, and 36% higher on the fourth night. Few studies are available that track trends in reporting injuries in more than four successive night shifts. Folkard and Akerstedt reference two studies that showed a decrease from the fourth to the fifth night, but the results are not extensive enough to conclude that the longer one stays on night shift, the lower the risk of injury/accidents (Folkard & Akerstedt, 2004).

This trend toward increased workplace accidents/injuries during night shift and other non-diurnal shifts is significant enough to generate research. In an effort to answer the question "Why and how do workers get hurt?", the answer usually involves sleepiness and resulting fatigue, maladapted workers dealing with biological imbalances, and performance deficiencies that result in carelessness and lack of attention to workplace hazards (Monk & Folkard, 1992). The repercussions of workplace accidents are more far reaching than just to the worker. These incidents can be a danger to society as a whole, such as errors on the part of airline pilots or nuclear power station operators, or a danger to the workplace, such as when a worker fails to follow lock-out tag-out procedures due to fatigue and inattention to detail (Monk et al., 1996). Therefore, despite some conflicting research as to the exact time of day when injuries/accidents are most likely to occur, the body of evidence that points to increased incidents linked to shift work in general is compelling enough to warrant further attention in the workplace. Shift work should be managed as an occupational hazard, and controls should be in place to decrease, to the greatest extent possible, workplace accidents/injuries.

Driving Accidents and Near Misses

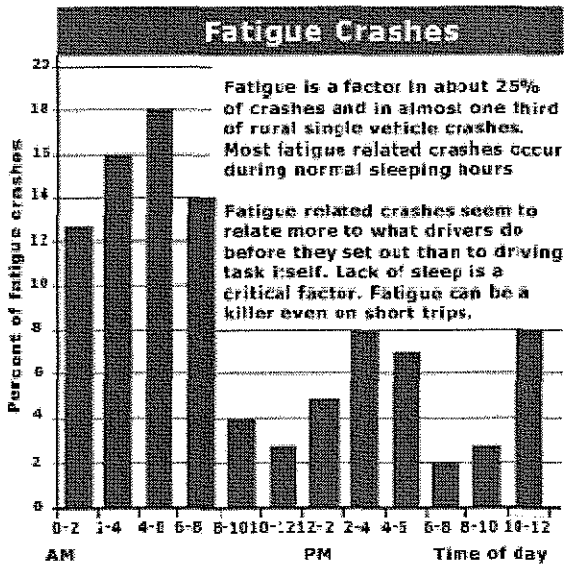
It is often difficult to say with certainty that a motor vehicle crash (MVC) was caused directly by the driver being fatigued, but professional investigators generally suspect fatigue to be an important factor if the accident 1) occurs late at night, early in the morning, or late in the afternoon, 2) involves a single driver, or 3) there is no evidence that the vehicle tried to stop, such as skid marks on the road (Australian Transport Safety Bureau, 2005). Sleepiness while driving is more identifiable and preventable as a cause of MVC than even alcohol and drug use (Rajaratnam & Arendt, 2001). Because of the fact that fatigue and sleepiness can not always be determined as the direct cause of an accident, the estimated annual monetary damage varies from $16 billion in the U. S. to $80 billion worldwide (Rajaratnam & Arendt, 2001). Figure 3.3 shows the percent of fatigue crashes over a 24 hour period of time. From this chart, it can be seen that nearly 60% of the crashes during this period occur between midnight and 8 am.

Fatigue tends to decrease reaction time in case of an unexpected highway event, and also interferes with the way information is processed (Australian Transport Safety Bureau, 2005). Some of the warning signs of fatigue that can have a dangerous effect on the ability of a driver to drive safely are:

- Yawning,
- Eyes feeling sore or heavy,
- Vision starting to blur,
- Start seeing things,
- Daydreaming and not concentrating,
- Becoming impatient,
- Feeling hungry or thirsty,
- Reactions seem slow,
- Feeling stiff or cramped,
- Driving speed creeps up or down,

FIGURE 3.3

FATIGUE CRASHES



Source: Australian Transport Safety Bureau, 2005.

- Starting to make poor gear changes, and
- Wandering over the center line or onto the road edge

(Australian Transportation Safety Bureau, 2005).

Many workers who work non-diurnal hours are negatively affected by the affects of fatigue combined with the need to drive, either in the course of the job, such as long distance truck drivers, or during the commute, to and from work. Interns leaving the hospital after long hours of work, sometimes as great as 40 or more hours, are more than twice as likely to have a MVC on the drive as after a non extended shift, and near misses were more than five times more likely in the same comparison (Barger et al., 2005). These statistics make MVC the leading cause of death in this group of workers (Barger et al., 2005).

A study conducted by the University of North Carolina Highway Safety Research Center found that drivers involved in sleep and fatigue-related crashes were up to 4 to 5 times more likely to be night shift workers (Smith, n.d). Other risk related factors determined by this study were sleeping less than six hours per night, being awake for 20 hour or longer, frequent driving between midnight and six in the morning, the use of certain medications that tend to cause drowsiness, and a previous problem with a sleep disorder. All of these risk factors have, in some way, been associated with shift workers.

Shift workers must contend with disruptions in circadian rhythms, as previously discussed. Most of these workers will confess to some type of sleep disturbance or decreased quality of sleep, and approximately one-third will complain of accompanying fatigue (National Heart, Lung, and Blood Institute [NHLBI], n. d.). If the added demands of family, second jobs, and social

responsibilities are considered, then shift workers are at a high level of risk for automobile crashes. Another factor placing shift workers in a high risk group for crashes is the fact that their numbers continue to grow, as the 24-hour society expands to provide more services around the clock, requiring more workers for evening, night, rotating, split, and irregular shifts (NHLBI, n. d.).

Gastrointestinal Problems

After disruptive sleep disorders and fatigue, GI negative health effects are the most commonly reported consequences of shift work (Monk & Folkard, 1992). As many as 3 out of 4 night workers have reported gastrointestinal (GI) disturbances such as decreased appetite, constipation, dyspepsia, heartburn, abdominal pain, and flatulence compared with only 1 in 5 day workers (Green-McKenzie & Behrman, 2005). Other reported GI symptoms are duodenitis and peptic ulcer disease, and workers with pre-existing conditions, such as Crohn's disease and ulcerative colitis have reported worsening of their conditions (Green-McKenzie & Behrman, 2005).

As with other systems in the body, the GI system and its associated digestive enzymes secretions follow a circadian pattern and are thus cyclical. When workers have unusual eating schedules because of odd work hours, this puts the GI system in a state of disharmony with its normal patterns, and negative symptoms occur (Muecke, 2005). Lifestyle factors including increased stress from home and social obligations, and organizational factors such as employers' lack of attention to dietary needs also affect the development of GI symptoms, especially in night shift workers. Shift workers may have to change their normal

eating habits because the employer does not provide nutritious food choices, such as from a cafeteria, during non-daytime hours (Scott, 2000). Some shift workers may bring their food from home, but others will rely on selections from vending machines or canteens. Canteens and vending machines generally do not provide the most nutritious of choices, so shift workers can develop unhealthy diets, which may be a contributing factor to GI problems.

Shift workers tend to consume more caffeine, alcohol, and/or tobacco in an attempt to offset the negative effects caused by sleep deprivation and fatigue. They are also more likely to eat food higher in sodium and fat, which can lead to problems other than those affecting the GI system, such as cardiovascular problems (Green-McKenzie & Behrman, 2005).

Many shift workers are able to adapt, somewhat, to the irregular eating patterns associated with working abnormal hours, and it might be several years before GI problems begin to appear (Green-McKenzie & Behrman, 2005). However, for those employees who recognize that their health may be in jeopardy and decide to return to a normal daytime schedule, some symptoms of GI health problems that they experienced during shift work may never completely resolve (Scott, 2000). The strong influence of the circadian system tells the human body when to suppress appetite, when to deplete its stores of food and energy, and when to excrete digestive enzymes. Working shift work hours forces employees to go against this natural cycle, and negative GI symptoms can develop (Monk & Folkard, 1992).

Stress and Psychosocial Issues

Workers cope with the stressors of shift work in a variety of ways making it a difficult area to assess. However, a worker's stress level is likely to increase due to shift work and result in sleep deprivation, a difficult home life, minimal interaction with children, lack of organizational support, and constant coping with the physical disruptions to all the system circadian rhythms (Monk & Folkard, 1992). Some indicators of the onset of stress, such as the increased use of prescription and non-prescription stimulants and increased cigarette smoking have been noted in shift workers, often with statistics showing a more than doubling rate for both (Monosky, 2004). There is a tendency toward higher rates of alcoholism, drug abuse, and caffeine intake among shift workers as well (Frank & Ovens, 2002). A study by Lennernas, Hambraeus, and Akerstedt (1995) found that alcohol use was higher on days off in all groups of shift workers.

Another factor that makes the determination of a causal relationship between shift work and increased stress more difficult is the element of negative affectivity. Individuals who rank high in negative affectivity tend to have overall negative perceptions of themselves and their environments (Parkes, 2003). Therefore, it is not altogether clear if the stress reported by these workers is due to shift work or to their individual personalities. There tends to be a high correlation between negative affectivity scores and greater job demands, lower levels of skill discretion, less control over one's job, less supervisor support, and less satisfaction with safety (Parkes, 2003).

In psychiatric research, a causal factor has been determined to exist between depression and a disruption in the circadian system. However, some shift work research has examined whether shift work and its accompanying circadian rhythm disruptions leads to or is a precursor to a depressive and higher stressed state in the shift worker (Monk & Folkard, 1992). One important circadian cycle that is disrupted by shift work is the production and secretion of cortisol, or the stress hormone. The blood levels of cortisol have been shown to increase with shift work, especially in those workers who rotate shifts quickly from morning to evening to nights, as well as in other workers, such as long-distance truck drivers (Lac & Chamoux, 2004). The concentration of cortisol in the body varies during a 24-hour period, but most of the time, it is higher in the early morning and lowest around midnight. Cortisol plays an integral role in allowing amino acids to produce glucose for energy. This chemical process results in a higher blood sugar level and an "energy directing" process that allows a person to deal with stressors in their environment. The night shift workers beginning their work time after midnight will have a disruption in this process and will not have the biological resources to deal with the stressful situations they may encounter (Stoppler, 2005). Changes in cortisol rhythms have also been associated with an inability to adapt to shift work due to self-perceived health problems (Lac & Chamoux, 2004).

Shift workers experience a higher rate of psychosocial problems involving their spouses, children, extended families, and their communities. Shift work often makes it difficult for workers to fulfill family and social obligations in a

satisfactory way that meets everyone's needs (Scott, 2000). Shift work is associated with higher rates of depression, divorce, suicide, burnout, and leaving professions that, at one time, provided personal fulfillment, such as in the profession of Emergency Medicine (Frank & Ovens, 2002). Chronic sleep deprivation plays a significant role in undermining workers' coping abilities, and when coping mechanisms fail, the result is often an impaired quality of life (D'Ambrosio, 2003).

The type of shift worked also affects the psychosocial well being of workers. Rotating shift workers tend to experience more fatigue, sleep debt, and nervousness than workers who are in permanent night shift positions (D'Ambrosio, 2003). Evening shifts tend to be more disruptive to family interaction, and workers in these positions find it difficult to balance their work life and family obligations (Scott, 2000).

The term work-home conflict has been defined as "a process in which one's functioning and behavior at home (work) is negatively influenced by demands made upon time and effort in the work (home) domain" (Demerouti et al., 2004, p. 990). These conflicts are not merely a factor of the amount of free time shift workers have, but how much of that free time can be utilized in a manner that allows workers to develop and nurture familial relationships as well as social and community relationships (Demerouti et al., 2004). For example, while working a week of fixed evening shifts, workers had only 17-23 common hours to be with their children. Workers on a rapid rotating shift were able to have 28-37 hours available to be with their children. These two scenarios

compare poorly to day workers, who had 43-60 weekly hours in common with their children (Demerouti et al., 2004). Such conflict between what workers have to do and what they feel they should be doing is a source of internal stress with many negative health sequelae. Shift workers also miss out on many social relationships and associated gatherings that tend to be great stress relievers after a busy workweek. Shift workers tends to be socially isolated forcing them to pursue more individual interests and causing a somewhat "loner" mentality (Frank & Ovens, 2002).

Shift workers tend to be a self-selected population, making it difficult to attribute depression/psychosocial problems and stress exclusively to shift work. There may have been some other, pre-existing psychiatric problems, such as bi-polar disorder or depression, that were involved at the onset of the shift work that are more of a determinant of the problem than the effects of the shift work. (Harrington, 2001). Due to the subjective nature of these disorders, researchers are trying to perfect better tools for measurement of shift work on mental health and psychosocial well-being, such as the general health questionnaire (GHQ) and the standard shift work index (SSI) (Harrington, 2001).

Effects on Pregnant Workers

From an epidemiological standpoint, early research studies that proposed a causal link between shift work and adverse pregnancy outcomes are valid, even though most were retrospective in design. The studies used large sample sizes and controlled for many confounding factors (Frazier & Grainger, 2003). Some of the research outcomes of these studies were:

- 60% increase in risk of preterm births,
- 30% increase in spontaneous abortions,
- Statistically significant associations between shift work and pre-eclampsia, and
- An increase in subfecundity (difficulty conceiving)

(Frazier & Grainger, 2003).

There are also higher risks of miscarriages and premature labor for shift workers, as well as an increase in menstrual cycle difficulties (Muecke, 2005). Follicle stimulating hormone is suppressed when a woman is sleep deprived and can affect ovulation and the ability to conceive (Frazier & Grainger, 2003). Melatonin production and secretion, when disrupted by shift work, can have a negative effect on pregnant workers possibly resulting in post-term births (Zhu, Hjollund, & Olsen, 2004).

In a study by Zhu et al. (2004), it was found that more shift workers than daytime workers changed jobs during pregnancy and were on leave more during this time. Historically, there were few options for pregnant workers once they were no longer able to perform their jobs. The Family and Medical Leave Act of 1993 provided a protected leave status for eligible workers allowing them to take a maternity leave for up to twelve weeks with guaranteed health insurance coverage (Frazier & Grainger, 2003). For many pregnant shift workers, this provided relief from the fear of losing jobs because of their pregnancy and time away from work after the baby was born.

The fetus can also be affected by the mother working shift work. A pregnant worker who works shift work hours is at a higher risk for prolonged pregnancy, but slightly adverse effects on fetal growth may result when this occurs (Zhu et al., 2004). Other studies have found a significant relative risk

(RR=1.6) of higher premature births in shift workers as well as an increased risk of spontaneous abortions and low birth weights, especially among workers who work rotating shift (Scott, 2000).

Some of the adverse health effects that have been previously mentioned as a result of shift work are especially magnified in the pregnant worker, and may have a more significant impact because of the added strain of the pregnancy and its accompanying health changes. Sleep deprivation, psychologic stresses, tobacco use, poor nutrition, and fatigue are some health effects associated with shift work that could have heightened consequences for the pregnant worker (Frazier & Grainger, 2003).

Miscellaneous Health Effects of Shift Work

Breast Cancer

In 2001, the National Cancer Institute of the United States published two journal articles indicating a link between shift work and breast cancer, especially when sleep was constantly disturbed. The articles also pointed to melatonin suppression in shift workers leading to suppression of ovarian estrogen, caused by light exposure at night, as an underlying risk factor for breast cancer (Spiegel & Sephton, 2002). The risk was found to be increased among participants who did shift work a long time, and who routinely worked more consecutive nights (Davis, Mirick, & Stevens, 2001).

In addition, cortisol rhythms were disrupted in workers with breast cancer. As previously mentioned, cortisol levels are normally high in the morning and then decline throughout the day. Researchers found that there was a higher

mortality in women with metastatic breast cancer who worked shift work, especially night shift work, and this was related to disruption of this normal diurnal cycle of cortisol production and secretion (Spiegel & Sephton, 2002).

There are many diseases, such as breast cancer, in which the incidence and severity increases with age. Many of the effects of shift work, including sleep deprivation with increased stress levels, various endocrine disturbances, and disruption of carbohydrate metabolism and thyroid hormone function are also seen in normal aging. It would follow that sleep deprivation can increase the risk of breast cancer, much like these disturbances would develop with advancing age (Spiegel & Sephton, 2002). Although the findings in these two studies could have been confounded by recall bias among the participants, the findings are significant enough to alert healthcare workers to this added risk for female shift workers.

Nutrition

Approximately 28% of extended hours workers, or those who work outside normal diurnal shifts, have diets that are balanced and healthy, as compared to an overall 33% of the general population (Monosky, 2004). The disruptive effects of altered biological rhythms have already been noted as affecting the quality of sleep, but this disruption in rhythms can also make food intake irregular and/or interfere with normal functioning (Altenburg de Assis, Kupek, Nahas, & Bellisle, 2003). Characteristics of night shift work diets that tend to cause problems for these employees are 1) higher caloric intake as each hour of the day progresses, 2) fewer protein enriched foods, and 3) more

carbohydrates and fats than morning or evening workers (Altenburg de Assis, et al., 2003).

The negative health effects of such irregular eating and altered nutrition has led to the discovery of many metabolic disturbances in shift workers, especially night workers. The endocrine system shows the negative effects of eating at night through increased blood lipid levels and higher low-density lipoprotein levels (Holmback et al., 2003). The production and secretion of other elements of the endocrine system, such as thyroid stimulating hormone, cortisol and pancreatic polypeptide, and insulin react differently depending upon the time of day that food is consumed; therefore, nocturnal eating can have a significant effect on this process, and severe alterations can lead to negative health consequences (Holmback et al., 2003). This is especially true for insulin, as it is more sensitive to caloric intake than some other elements. It may be very difficult for night shift workers to regulate glucose levels, since studies of abnormal levels of insulin show that the body does not react that well to high caloric intake at night (Holmback et al., 2003).

Ha and Park (2005) cite a 1996 study by Neidhammer that showed an estimated 2 lb (.9 kg) weight gain for every 5 years of shift work. Obesity tends to be more prevalent in shift workers than in day workers (Holmback et al., 2003). This could be caused by a combination of factors including availability of food during night shifts (usually from a vending machine or fast food canteen), the time of day that food is consumed relative to the times of greatest energy expenditure, (day workers consume 40% of their total calories in the morning

when the most energy will be spent), the spacing of meals, and the age and the basic metabolic index (BMI) of the individual worker (Altenburg de Assis et al., 2003).

The literature does not consistently portray a negative slant on the diets and nutritional states of shift workers. Lennernas, Hambraeus, and Akerstedt (1993, 1995) found that many night workers tend to bring meals from home because of poor food choices at night, and this proved to be healthier, while helping night shift workers to avoid overeating. They found that shift workers tend to eat more snacks (high carbohydrates, high fats) than day workers. Night workers socialized more during meals, and tended to eat as a group more often than day workers. Many shift workers stated that they ate more snacks because of slow work times and boredom. Although these two studies did not support other evidence of less adequate diets in shift workers, the authors did concur that nocturnal eating can have negative consequences on metabolic systems due to disturbances in circadian rhythms as previously discussed.

Aging Workers

The Department of Labor estimates that there are approximately 3 million older workers between the ages of 45-64 on night and rotating shifts (Duffy, 2003). These workers face some of the same challenges working shift work that younger workers face, but the negative health impacts will be magnified in these workers because of the added effects of the aging process itself (Duffy, 2003). Aging workers tend to be "morning people" which causes them to lose much of

their ability to adapt to disrupted circadian rhythms, especially disrupted sleep patterns, even when in permanent night jobs (Muecke, 2005).

The quality of sleep is independently negatively related to aging as well as to years working shift work hours. Aging workers tend to sleep more prior to a morning shift than younger workers, wake more easily during day sleep (less able to sleep an appreciable amount of time after a night shift), and do not get a significant amount of restorative sleep (Harma, 1996). These characteristics of decreased sleep quality will occur naturally with the aging process, and the added impact of shift work will only magnify the severity of the poor quality of sleep among aging shift workers.

To compensate for these natural obstacles to sleep, aging workers tend to be more diligent about going to bed earlier and do not experience the level of sensitivity to acute sleep loss than younger workers (Harma, 1996). It might be assumed that with age comes a better ability to adapt to the effects of shift work since they have more experience, fewer domestic responsibilities, and they can often function with less sleep, but research findings do not support this theory (Harrington, 2001). Older workers also tend to have less negative affectivity and a healthier work ethic than younger workers, which would be a positive element in their coping abilities, but even this is not enough to overcome the effects of disrupted sleep (Parkes, 2003).

Aging is one of the most common causes of decreased tolerance to shift work (Harma, 1996). It is not so much a lessening need for sleep, but aging workers are not able to achieve the quality sleep needed during their hours off to

counteract the negative affects of disrupted sleep patterns brought on by shift work (Harrington, 2001). They build up a greater sleep debt than younger workers and have a more difficult time readjusting during their times off (Duffy, 2003). Aging workers tend to depend more upon hypnotic medication use than other workers (Marquie & Foret, 1999). The onset of age related diseases tends to be accelerated in aging workers. Even when these workers leave shift work, they continue to have a higher incidence of sleep disorders and other negative health sequelae than those who never worked shift work (Marquie & Foret, 1999).

With the ever present trend to eliminate age discrimination, dealing with the health problems of the aging worker will only become more challenging. It is not advisable to begin shift work at an older age, and this has been substantiated through research (Monk & Folkard, 1992). This must be carefully considered in the workplace especially as the baby boomers enter their fifties and sixties.

CHAPTER IV

THE ROLE OF THE OCCUPATIONAL AND ENVIRONMENTAL HEALTH NURSE

The Occupational and Environmental Health Nurse (OEHN) is in an important position to assist the employer and the employee in assessing, evaluating, documenting, and controlling the negative effects that shift work may cause in the workplace as well as to the health of the workers. Employees come to the OEHN with a variety of complaints, which can be physical, organizational, or interpersonal in nature. With good history taking skills, combined with knowledge of the manifestations of negative health effects related to shift work, the OEHN can assist the worker with developing coping mechanisms either through individual efforts or through working with the employer for a possible scheduling or workplace design solution. The OEHN may consult with management about the rationale for changes that might result in amelioration of the negative effects that shift workers are experiencing, as well as assistance with the development of related policies and medical screening procedures. Employees can benefit from being educated by the OEHN on how to manage their health response to shift work to function optimally under non-diurnal work schedules.

Consultation

Worksite Assessment

It is important to the success of a worksite assessment that the company views this as a preventative, proactive measure, rather than just a temporary

measure to cut costs or stop employee complaints (Rogers, 2003). A commitment to a healthy workforce should include well thought out policies, resources to address problems, appropriate medical screenings, and control measures aimed specifically at abatement of obvious problems (Rogers, 2003).

The OEHN, having a solid knowledge of how shift work may affect workers, will need to be aware of employees exhibiting signs and symptoms of negative effects on health and performance, while also being aware of individual differences, especially in highly susceptible employees such as the aging or pregnant worker. In a holistic approach to a worksite assessment, the OEHN can also evaluate the environment, noting triggers for problems such as poor night lighting and lack of adequate and nutritious food choices for all shifts.

The OEHN can track injuries and look for patterns of worker behavior, such as napping during breaks, being tardy to work, and other clues that could mean the beginning of maladaptation syndrome (Glazner, 1991). Questionnaires are useful tools to determine morningness/eveningness, sleeping preferences, reactions to sleep deprivation, driving records, maladaptation or adequate functioning on non-diurnal shifts (Glazner, 1991). The OEHN may be the first person to recognize that a general complaint on the part of the worker is really a precursor to shift work maladaptation and/or negative health effects.

Policies/Procedures Related to Shift work

The United States has fallen behind European countries that have taken a lead in recognizing the negative effects of shift work and have adopted policies and enacted laws that offer workers a level of protection. In 1992, women were

prohibited from shift work in Belgium, Czechoslovakia, France, Germany, Italy, the Netherlands, and Norway. France, Brazil, and other countries in Europe have limited working hours per week and have also mandated at least 11 hours of off duty between shifts (Monk & Folkard, 1992). As mentioned previously, there are very few specific laws governing work hours in the United States.

It can be difficult for companies to buy into the necessity of changing their shift working hours, based solely on "chronobiological principles", such as the effects of disrupted circadian cycles (Monk & Folkard, 1992). The OEHN must realize that the elimination or reduction of night work may simply not be an option for a company, as well as the fact that many workers actually choose night work and have built a delicate life balance around working non-diurnal hours (Monk et al., 1996). The best approach is one that would include a participatory approach between management and employees. There is valid research that shows the positive effects of having the employees involved with the design of work schedules (Baker et al., 2004).

Some policy changes may be easier to introduce than others, for instance, temporarily reassigning pregnant workers to day shifts, or allowing workers past the age of 45 to opt for day time, non rotating shifts. Others may be more difficult, such as eliminating backward rotating schedules. The OEHN can play an important role in educating management about the advantages of such policy changes using administrative controls. Administrative controls, specifically the development of shift friendly policies, may be the best solution to the problems created by shift work, since the issues caused by fatigue cannot really be

addressed by traditional methods such as substitution and personal protective equipment (Frank, 2000).

The OEHN may also work with union representatives to achieve the goals of reducing the effects of shift work and implementing worker-friendly policies. The OEHN can be a resource for information on the health effects of shift work, as well as possible solutions for scheduling issues, to those in the company responsible for negotiating union contracts. Even with convincing documentation supporting change, the OEHN may still be faced with union rules regarding set work assignments and differing pay scales.

To solve the complex situations arising from shift work and to develop strong, effective policies, a coordinated effort is needed. Policies should be well planned, implemented, and evaluated periodically to assess progress and determine areas for improvement (Kogi, 1996). Table 4.1 shows a checklist of items that might be considered prior to making company wide changes. The list covers 48 items that would be helpful in establishing priorities and developing company policies to address the issues.

Health Screening

Given the fact that definitive research about the relationship of shift work to negative health outcomes is often questioned in terms of being absolute (the direct cause of the health problem), it is challenging for the OEHN to counsel employers as to the best medical screening and surveillance protocols for those employees who are either being considered for hire or for those who are currently

TABLE 4.1

NIGHT AND SHIFT WORK CHECK LIST

CHECK ITEM	DO YOU PROPOSE ACTION?		
	NO	YES	PRIORITY
I. SAFE AND ERGONOMIC WORK TASKS			
1. Transfer to daytime some of the tasks that can be more dangerous during night shifts.			
2. Use safer, less strenuous work methods particularly for night shifts.			
3. Strengthen measures limiting the effects of human errors.			
4. Make sure that safe work procedures are observed properly in carrying out hazardous work tasks particularly during night shifts.			
5. Agree on and apply good teamwork procedures appropriate for both daytime and night work.			
6. Avoid isolated tasks done during night shifts.			
7. Improve ventilation and install air-conditioning to enhance thermal comfort in all shifts.			
8. Secure adequate lighting for all tasks including those done only occasionally at night.			
9. Isolate or screen sources of work-disturbing noise.			
10. Keep passageways and access routes cleared from obstacles at all times by organizing materials and tools storage properly.			
11. Work at elbow height in natural postures avoiding bending twisting or arm-raising postures as much as possible.			
12. Use hand-trucks, lifting devices or other mechanical means for moving heavy or frequently handles materials.			
13. Make signals, displays or instructions easy to identify at all times, using for example color coding.			
14. Establish time-frame and procedures of transmitting verbally and in writing safety-related and other essential information to the crew of the next shift.			
15. Promote good communication between workers and between managers and workers.			
16. Establish emergency communication procedures, such as first aid and fire-fighting, and keep them posted at all times.			
17. Designate key persons responsible for managing safety and health risks on a continual basis including all shifts.			
II. Better Working Time arrangements			
18. Make specific plans for working hours per day, week, month or year.			
19. Fix shift lengths adequate for tasks loads (for example, long shifts only for non-strenuous, relatively intermittent work).			
20. Avoid short intervals of time off between two shifts, such as 8 or 10 hours only.			
21. Plan days off at adequate intervals.			
22. Make some weekends free.			
23. Keep rotas regular.			
24. Make plans for substituting absent workers in advance.			
25. Minimize the number of consecutive night shifts.			
26. Allow some individual flexibility in working different shifts.			
27. Make an annual plan for coordinating frequencies of night shifts, daytime shifts, days off and leave periods.			

CHECK ITEM	DO YOU PROPOSE ACTION?		
	NO	YES	PRIORITY
III. Support for Resting and Health Promotion			
28. Insert breaks of adequate length during each shift including a night shift.			
29. Allow a napping period of adequate length during a night shift depending on the needs and preferences of workers.			
30. Provide comfortable and hygienic facilities for resting and, where appropriate, for napping.			
31. Provide, where appropriate, sleeping facilities that are air-conditioned and undisturbed by environmental noise.			
32. Provide information and training about planning adequate sleep time-tables and reducing sleep disturbances.			
33. Give concrete support for improving sleep environment at workers' residence.			
34. Provide information about taking meals appropriately also taking individual workers' habits into account.			
35. Provide information and necessary supporting facilities for getting nutritious meals suitable for all shifts including night shifts.			
36. Provide information and arrange for supporting facilities for keeping physical fitness.			
37. Organize educational sessions for workers about self-check of their health and improving their coping behavior.			
38. Provided counseling services by occupational physicians, occupational health nurses, nutritionists or psychologists about maintaining and promoting the health of workers.			
39. Monitor at regular intervals the physical and mental health problems of night and shift workers and use the results for taking appropriate workplace action.			
40. Provide support for transport facilities particularly before and after night shifts.			
41. Encourage workers to share household duties and make time-spaces to be with and to eat with their spouses and children.			
42. Encourage and support workers to plan free-time activities positively.			
IV. Lifecycle Development and Safety Culture			
43. Conduct educational programs for all new night and shift workers about how to deal with irregular shifts and about improving safety at work.			
44. Organize groups training workshops for managers and workers about adjusting to night and shift work and improving workplace conditions.			
45. Prepare and distribute easy to understand leaflets for workers about risks due to night and shift work and necessary countermeasures.			
46. Promote means of transferring work skills and techniques for planning and implementing night work tasks to younger workers.			
47. Provide opportunities of acquiring and upgrading working skills and expertise.			
48. Make publicity effort for making known the advantage of shift working jobs.			

Source: Kogi, 2004, Appendix.

working shift work hours. There is no one specific medical screening test which can accurately predict which worker will experience adverse health effects from shift work, but a well-worded questionnaire can be a good tool to screen for those applicants who may be at risk for developing shift maladaptation syndrome and accompanying adverse health effects (Sood, 2003). Medical screening has been defined as "the administration of a medical test for the purpose of detecting organ dysfunction or disease before the person normally would seek medical care and at a time when intervention is beneficial" (Sood, 2003, p. 339). Since the onset of problems associated with shift work can take months, and, in some cases, years to manifest, the traditional course of pre-placement medical screening and screening for ongoing surveillance purposes may not give a complete picture of the future health problems that workers may encounter.

Green-McKenzie and Behrman (2005) created a guideline for health care professionals to use in developing questionnaires to identify those individuals who may need help with counseling and coping strategies while working shift work as well as determining those individuals for whom shift work would be an absolute contraindication. Relative contraindications that may require counseling and coping strategies are:

- Mild asthma,
- History of insomnia,
- Greater than 40 years old,
- Cardiac risk factors,
- History of depression,
- Use of medications with circadian variation,
- History of seizures (not controlled by medications),
- Frequent indigestion,
- Crohn's disease,
- Family instability,

- Excessive family responsibilities, and
- Long commute to work.

Absolute contraindications to shift work would be:

- Epilepsy requiring medication in the last year,
- Coronary artery disease with unstable angina,
- History of myocardial infarction,
- Asthma (on regular medications or steroids),
- Insulin-dependent diabetes,
- Hypertension on multiple drugs,
- Multiple medications,
- Recurrent peptic ulcers,
- Severe irritable bowel syndrome,
- Chronic depression or long-term psychotropic drug use, and
- History of shift maladaptive syndrome from another workplace (Green-McKenzie & Behrman, 2005).

The best course of action for each workplace is to develop a site-specific screening questionnaire. The health care professional would review the results to determine if further surveillance is needed for workers who are at high risk for shift work based health problems. It could also reveal an applicant who is a very poor candidate for shift work (Sood, 2003). Questionnaires can reveal such things as poor nutritional habits as well as changes in the use of alcohol, tobacco, caffeine, and sleeping pills that may affect the way workers adapt to shift work.

If pre-placement testing and ongoing health surveillance is performed in the workplace to provide early intervention for shift work health problems, the tests should be specific to those risk factors that have been associated with negative health effects and substantiated by research. Serum lipoprotein and triglyceride levels, blood pressure monitoring, weight, and body fat assessment have been suggested by multiple researchers as good screening tests to determine risk for shift work maladaptation syndrome (Scott, 2000).

The OEHN can assist with an in-depth evaluation of all circumstances that may lead to a particular health effect experienced by workers, including health screening results and potential environmental factors. A worksite assessment can be done to determine if abnormal testing might have been caused by an environmental problem, such as poor workplace design. The OEHN can also be a valuable resource with legal issues involved in pre-placement and surveillance health screening, such as the Americans With Disabilities Act, record keeping, and confidentiality issues related to the Health Insurance Portability and Accountability Act (HIPAA) (Sood, 2003). The OEHN can act as an advisor to shift workers about their health concerns and assist with coping strategies when possible (LaDou, 1997).

Control Measures

As the global economy becomes increasingly dependent upon operating on a 24/7 continuous cycle, shift work will continue in the workplace. Therefore, there must be an ongoing effort to control, to the extent possible, how the work environment associated with shift work affects the worker. In addition to worker friendly policies and appropriate health screening, controls can also be implemented through better scheduling and workplace design.

Scheduling

There are many types of shift schedules, and other than working permanent diurnal hours with weekend breaks, every shift schedule has been associated with some type of negative health effect. By general consensus, forward rotating (day, evening, night), with rapid changes (every 2-3 days) is less

detrimental to worker health than backward rotation (day, night, evening) (Frank & Ovens, 2002). This type of shift has less interference with natural circadian rhythms (Harrington, 2001). However, rapid rotation has also been criticized because of its less predictable schedule, and has been linked to excessive sleepiness on the night shift portion of the rotation (Monk et al., 1996).

A recent trend in the workplace is toward "flex hours", whereby an employer will allow employees to choose their beginning and ending times for work. These trends are more prevalent among workers in executive, administration, and managerial occupations and sales, and are found less frequently among workers in occupations that demand a set beginning and end work time, such as nurses, police, fire, and emergency personnel (Beers, 2000). Baker et al. (2004) found that an individual's tolerance to shift work was related to his/her level of control, in that the greater the control, the better the tolerance.

There is also consensus among researchers that permanent or fixed night shifts pose a greater risk to the health of workers. Although workers have a predictable schedule, this shift allows workers very little time for social and family interactions, and sleep debt is built up such that it cannot be dissipated over breaks between work weeks (Monk et al., 1996). This combination of psychosocial and physical strain can be very detrimental to workers' health.

Finally, research on trends in accidents and injuries points to the benefit of restricting the length of shifts to no more than 12 hours, and ideally, 8 hours (Folkard et al., 2005). A study of emergency medical workers found that a change from a 24 to a 12-hour shift resulted in greater satisfaction with

scheduling, and a decrease in social disruptions and emotional exhaustion felt by workers (Monosky, 2004).

Workplace Design and Environment

The literature is fairly consistent in emphasizing the importance of light as being a strong influence on the body's circadian rhythms. In laboratory studies, exposure to bright light at night showed a beneficial effect on a worker's level of alertness and level of fatigue (AHRQ, 2001). Bright lighting in the workplace has also been shown to suppress the production of melatonin in the body, which can decrease the level of sleepiness and tiredness experienced by workers (Monk & Folkard, 1992). The process of entrainment or retraining the circadian rhythms of the body to adjust to nocturnal work hours has been proven to be optimal if, in addition to bright lighting during the night shift, there could also be rigid darkness during the daytime sleep hours. However, this combination is difficult to achieve outside a controlled laboratory setting (Monk & Folkard, 1992).

Other workplace design considerations include keeping temperatures cool to help offset drowsiness, providing background music to avoid monotonous sounds, and providing areas appropriate for social interaction during meal and break periods (Schwerha, 2005). Some very employee friendly workplaces will also provide 24-hour day care for children of employees (Schwerha, 2005).

The design of the workload itself can be an element in preventing shift related errors. Workers are most likely to perform simple perceptual-motor tasks (i.e., assembly line work) with more speed and safety as the daytime hours progress, whereas short-term memory tasks are more efficiently performed during

the morning hours of 8 am to 11 am (Folkard & Tucker, 2003). Since risk assessments for accidents and injuries are more often based on highly repetitive perceptual motor tasks, this would indicate to an employer that the majority of its production tasks should be assigned to day shift workers, and those tasks requiring less perceptual accuracy (lower risk) should be assigned to night workers, such as routine maintenance and cleaning tasks, and longer, uninterrupted assembly line runs. While this may be an option for a manufacturing setting, it is not a viable solution for service occupations, such as police, fire, and healthcare providers.

Finally, an employer should take all necessary precautions to protect workers who work hours greater than 8 hours/day, 5 days/week from excessive toxic exposure. Occupational exposure limits are based on a standard 8-hour workday schedule, and consideration must be given to those workers who work 10 or 12-hour shifts and a lot of weekly overtime (Harrington, 2001). The OEHN can be a good resource for the company, working together with industrial hygiene and safety specialists, to make sure workers are protected during all hours of work, through appropriate engineering, administrative, and personal protective control measures.

Education for Employees

Sleep Patterns

Sleep patterns have been shown to be the single most important factor in determining the level of adaptation to shiftwork that workers can achieve (Smith et al., 1999). Effective sleeping habits and good sleep hygiene are essential in

preventing many of the biological and psychological negative effects of shiftwork. Workers will need to develop individual strategies to cope with the disruptions inherent to daytime sleep, whether they are fighting the natural tendency to be awake or dealing with nonwork disturbances, such as children in the home, street noise, or the pressures of social obligations. (Smith et al., 1999).

In educating workers about healthy sleep patterns, the OEHN should make employees aware of the signs of inadequate sleep, such as falling asleep while driving or difficulty concentrating on tasks. Employees should also be cautioned in using over the counter sleep medications (Spengler, Browning, & Reed, 2004). The continued use of melatonin to counteract the fatigue caused by rotating shifts is not recommended due to inadequate research on the long-term effects of use (AHRQ, 2001). In addition, it is also not wise to recommend unlimited use of stimulants or consumption of caffeine (AHRQ, 2001).

The elements of good sleep hygiene include using a bedroom for sleep and sex only, and regulating temperature (68-75 degrees), light, and noise during times of sleep (Baker et al., 2004). Other helpful strategies for more effective sleep are:

- White noise, such as a fan,
- Ceiling tiles and carpeting,
- Earplugs,
- Telephone in bedroom unplugged,
- Eye shades (sleep masks), and
- Heavy shades or other window darkening coverings

(Schwerha, 2005).

Napping can be a strategy used by workers to combat fatigue, increase reasoning skills, and improve alertness (AHRQ, 2001). For night workers, short

afternoon or evening naps are beneficial and going to bed as early as possible after a night shift helps maximize the daytime sleep (NIOSH, 1997). Napping should not be a part of the main sleep, and if naps are permissible at work, they should be no more than 20-30 minutes (NIOSH, 1997). Performance has been shown to be improved by a short nap (<15 minutes) in the mid-afternoon after a sleep-deprived night. This improvement in performance has been demonstrated by reports of decreased major and minor driving incidents (Rajaratnam & Arendt, 2001). Caffeine in small amounts (150 mg) combined with short naps has been shown to be an effective combination (Rajaratnam & Arendt, 2001).

Nutrition

The negative effects of shift work on the gastrointestinal system have already been discussed. The eating habits of shift workers are a major contributing factor of gastrointestinal disturbances and negatively impact the circadian rhythm of metabolism (Lennernas et al., 1993, 1995). The types of food eaten, the times taken for meals, and the overall general nutrition of workers can have a significant impact on how they are able to function. Non-diurnal workers do not have the advantage of healthy food choices during these hours, as evidenced by vending machines and canteens that only offer snack food choices low in nutrition value or more nutritious cafeteria fare available to daytime employees.

The OEHN can educate shift workers in making wise decisions regarding overall nutritional health as well as by providing helpful alternatives to eating only from vending machines. The OEHN can provide learning sessions on

bringing food from home including tips for easy to prepare meals, such as sandwiches, fruit, prepackaged microwave meals, and nutritional snack bars. Shift workers who bring their own meals to work tend to eat a healthier selection of foods and experience fewer overeating and weight gain problems (Lennernas et al., 1995). The OEHN can encourage employers to provide the employees with access to microwaves, refrigerators, and nutritious vending machine choices such as fruit, low fat dairy products, whole grain products, and light entrees (Schwerha, 2005).

The OEHN can educate workers as to other general nutritional guidelines such as avoiding fatty and sugary foods, which contribute to weight gain while working shifts, as well as avoiding excessive caffeine consumption (limit 1-3 cups early in a shift) (NIOSH, 1997). Shift workers should also avoid heavy greasy or spicy foods since the disruption to the circadian rhythm of digestion makes these types of foods very difficult to digest (Schwerha, 2005). The OEHN should caution shift workers to be especially careful of alcohol intake. While alcohol can help one fall asleep easily, it will cause awakening too soon, thereby reducing the overall quality of sleep (NIOSH, 1997). In general, shift workers should strive for nutritious, well-balanced meals and regularity of meal times while working in order to minimize the adverse effects caused by the disruption to circadian rhythms of digestion (Knutsson & Boggild, 2000).

Habits and Patterns

Shift work can present a special set of challenges to employees as they attempt to avoid physical, emotional, and social stressors caused by the inherent

disturbances to life outside diurnal hours. The OEHN must educate the shift worker on the importance of making time for restorative, relaxing activities, since such habits can greatly improved overall productivity and general satisfaction with work (Spengler et al., 2004). Counseling advice for the worker can include educating friends and family about shiftwork in order to build psychosocial support, reducing non work stressors where possible, and becoming involved in the community to advocate for shift worker-friendly community services (Monk & Folkard, 1992).

The benefits of physical fitness are especially true for shift workers. Harma (1996) reports on a Finnish study that reported 30% of men and women claimed exercise to be the most important factor in improving their quality of sleep. The OEHN can make the following recommendations regarding exercise habits for shift workers:

- Exercise in moderation rather than intense training,
- Exercise several hours prior to the main portion of sleep, and
- Exercise after an early morning or day shift and before an evening nap (Harma, 1996).

While exercise and physical fitness are beneficial to all workers, shift workers can greatly benefit in lower heart rates at work, better orthostatic tolerance, and quicker recovery after intense periods of work (Harma, 1996).

There is a strong association between shiftwork and smoking which could either be linked to increased stress or to coping mechanisms used to combat sleepiness and fatigue (Knutsson & Boggild, 2000). Compared to day workers, it has been found that the number of cigarettes per day significantly increased in

shift workers (Knutsson & Boggild, 2000). The OEHN should help workers understand that this is an ineffective and physically harmful coping effort.

In a holistic approach to the problems encountered with working shift work, the occupational health professional must look beyond just the clinical implications. Glazner (1991) quotes Rutenfranz, an early pioneer in shift work research:

> To sum up, the occupational health measures for night and shift workers should include all the appropriate actions required to reduce complaints of the workers in order to prevent lowering of well being, and the occurrence of job related diseases. Such measures should not be restricted only to those used in normal occupational health practice, but also should encompass activities outside the workplace such as pressing for amelioration of housing conditions and advising workers on the organization of their social life in relation to shift systems based on physiological criteria. (p. 420)

CHAPTER V

DISCUSSION AND CONCLUSIONS

Summary of Findings

Shift work, or work done outside of normal daylight hours, is prevalent in a wide variety of occupations. Shift work scheduling can be any combination of hours worked that meet the production or service needs of a given occupation. There are few laws that directly address shift work, and those that do relate to specific occupations such as the trucking and airline industries. Working shift work hours and having inconsistent sleep/wake cycles can cause workers to experience disruptions in normal biological rhythms, and this can lead to negative health effects.

There is an increasing amount of research being conducted on the health effects of shift work. Research is being driven by the exponential pace at which technology, globalization, and the demand for services and goods on a 24/7 basis is resulting in an increase in the number of shift workers experiencing negative health effects. For example, fatigue, stress, and sleep disorders are some of the effects that have been linked to shift work. Discrepancies exist in many of the research studies in formulating clear causal relationships between shift work and various health effects. However, the current research is adequate to connect shift work with many negative health effects in workers and should not be ignored.

There are some consistent findings in many of the related research studies, specifically the importance of adequate rest for shift workers, especially during

high demand periods of work (Spengler et. al., 2004). Linking individual accidents and injuries as well as catastrophic events to worker fatigue and sleep deprivation has also highlighted the need for more attention to be given to the effects of shift work.

As more occupational health professionals recognize patterns of shift maladaptation syndrome in workers and the resulting negative health effects, they can serve as an advocate to assist employers and employees with personal and professional coping skills. The OEHN can be an important first contact for workers who may be experiencing negative health effects from shift work. The OEHN can also assume the role of consultant to employers to assist with worksite assessment, implementation of worker-friendly policies and procedures related to shift work, and more efficient workplace design and scheduling practices. This means that the OEHN should have a broad base of knowledge of how shift work will affect workers and how attention to scheduling and workplace design will improve performance.

Impact of Findings

Smith (2003) conducted a study and proposed that extended hours operations are costing businesses more than daytime operations. The report cited lower productivity, higher absenteeism, greater employee turnover, increased health care costs and more job-related accidents among shift workers, resulting in a nearly $205.4 billion dollar loss to businesses annually. The push for 24/7 service is a tremendous economic pressure for business, while at the same time, causes workers to react negatively to the work schedule (Smith, 2003).

As the number of shift workers continues to grow and more research studies confirm a causal relationship between shift work and negative health and productivity effects, employers will be forced to review their scheduling policies to arrive at better solutions for the workplace and their workers. In the event that other high profile incidents are linked to fatigue, such as the Exxon Valdes and the Challenger disasters, they will act as catalysts to spur further investigation, and possible changes for the better in shift operations.

Future Research Implications

The need for more empirical, well-designed research has been mentioned. Monk and Folkard (1992) recognized early on that much of the research being done in the area of shift work was done for profit and was not substantiated in peer reviewed journals. Since shift work will likely increase in the future, the focus should be on new ways of allowing employees to get adequate rest and experience fewer disruptions in normal circadian rhythms (Spengler et al., 2004).

The field is not without new research. Electronic monitoring of employees has been used to check for dangerous levels of fatigue using testing devices claiming to be able to measure fatigue levels and/or the use of drugs, but this is still a new and unproven area (NIOSH, 1997). There are ongoing studies to determine a clearer understanding of the effects of shift work on the reproductive system, including teratogenic effects and reproductive consequences in the female worker (Labyak, Lava, Turek, & Zee, 2002). Research will also continue to investigate specific inconsistencies, such as conflicting studies showing higher risk for health effects and accidents in shift workers, but also showing more

alertness during the evening hours (Folkard & Akerstedt, 2004). Other current studies address the use of specific chemicals, such as Modafinil, which is currently used to treat narcolepsy, but needs to be studied in more depth before it could be recommended for shift work sleep disorders (Green-McKenzie & Behrman, 2005). Knutsson and Boggild (2000) pointed specifically to the need for research into cardiovascular outcomes of shift work, particularly for employees working two shifts and permanent evening shifts, as compared with permanent night workers.

The OEHN, realizing the various deficient areas of shift work research, can conduct workplace research using worker populations available, such as pregnant or aging workers. The OEHN generally has access to accident/injury rates and demographic and personal health data gathered during employee clinic visits. Through a review of this data, the OEHN can track trends that could reveal potential problems among shift workers. Depending upon the extent of available data, this research could either be retrospective or prospective. Either way, results could be used to influence workplace policy, scheduling, and workplace design with the goal of improving workers' adaptation to shift work.

Conclusions

Our society finds itself at the beginning of the 21st century in a dilemma, caused by a conflict between the technology explosion of the 20th century that helped create a 24/7 world and the ever growing evidence that biological and psychosocial needs of shift workers are often ignored. The challenge becomes

finding ways to protect the health and safety of workers since shift work will continue. There are champions who support innovative solutions to the problems associated with shift work through research, education, publication, and legislation. However, when employers are swayed by consumer demands and economic pressures, they often choose profit and production over the health and safety of their workers. This approach can have dangerous consequences for workers and for the public.

In order to be responsible with regards to shift workers and their specific needs, it must be determined if the gains realized from increased technology and continuous work to produce goods and services is worth the price of disaster that can result from one fatigued, sleep-deprived doctor, air traffic controller, or long distance truck driver. There is also the possibility that shift work is contributing to an ever growing population of workers with a variety of health problems that may or may not be directly related to an imbalance in the way humans were intended to function and the schedules dictated by the workplace.

In knowing that shift work is here to stay and that the safety and health of workers can be compromised by shift work, what is the solution for the workers? First of all, employees can be educated and encouraged to realize personal limitations and to define their optimal level of functioning. For example, the realization that one is a "morning person" should be an indicator to avoid shift work if possible. The OEHN can be an excellent resource to help employees identify risk factors that might cause disruptions to health. The OEHN is often the first person to recognize a trend in behavior that could lead to maladaptation

syndrome. Employers can be guided by the OEHN to respect the needs of their worker population, be open to compromise, and be flexible in dealing with the needs of shift workers. The OEHN can be a resource for information about various scheduling strategies and workplace design modifications that would help workers to adapt to the shift work environment.

The OEHN must be current on the research that is available on shift work, especially if it pertains to a particular segment of his/her workplace population, such as pregnant or aging workers. The OEHN could also conduct his/her own research on a specific worker population by evaluating clinic visits, absenteeism, and health insurance claims and occupational injury incidents. As an occupational health professional, the OEHN has a specialized base of knowledge regarding health issues, safety, workplace assessment, and exposure hazards and should be at the forefront of issues dealing with shift work as consultants, educators and policy makers.

You made my body, Lord; now give me sense to heed your laws.

Psalm 119:73

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